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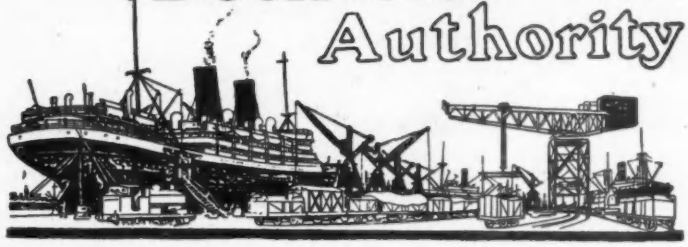

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Editorial Comments

Belfast Harbour Centenary.

The centenary celebrations of the Belfast Harbour Board, briefly referred to in our last issue, created much interest and enthusiasm, the civic functions especially, being attended by many distinguished guests from all parts of the United Kingdom. The occasion was suitably commemorated by a "Harbour Week" which lasted from 16th to 22nd June, and by the publication of a brochure containing a short history of the port, excerpts from which will be found on another page.

A centenary is a milestone of great importance in the history of any undertaking, and although records of the Port of Belfast can be traced as far back as 1663, the development of the harbour and docks has only been brought about since 1847, the year in which the "Belfast Harbour Act" was placed on the Statute Book. Since then, the advance of the port has been remarkable, so that to-day, it has a world-wide reputation as a notable shipping and shipbuilding centre, serving an important industrial and commercial area.

Industry in Belfast and the provincial towns of Northern Ireland has kept pace with the development of the port, and the successful combination of maritime and industrial enterprise has been responsible for sending abroad an impressive volume of exports, including large quantities of machinery, whisky and agricultural produce. It is also worthy of note that, before the recent war, Ulster linen ranked as the second export of the United Kingdom.

At the recent celebrations, tribute was justly paid by Mr. John McCaughey, Chairman of the Harbour Commissioners, to the vision and enterprise of their predecessors "whose initial planning and constructive works to meet the requirements of their day formed the basis on which all subsequent developments had been carried out."

We are confident our readers will join us in congratulating the Harbour Commissioners and their staff on their past achievements and in wishing them continued success and prosperity in the years to come.

International Conference on Inland Waterways.

The unaccountable neglect to exploit to the full the great potentialities of inland water transport in Great Britain which has been the subject of much regret from the point of view of the country's internal economy, lends undoubted importance to the recent International Conference on Inland Waterways, held in Paris, from June 26th to 28th last. The object of the Conference was to make known to business people and industrialists and the public at large, the value and commercial interest of Inland Water Transport, and to give inland waterway operators from different countries the opportunity for discussions on organisation, management and technical information. In this sphere of commercial activity there has been far greater enterprise displayed on the Continent of Europe, especially in the Low Countries, where there are valuable networks of internal water communication and great trunk routes exemplified in Holland by the Juliana Canal and in Belgium by the Albert Canal, both constructed during the years immediately preceding the late war.

The Conference, which was under the Chairmanship of M. Jules Moch, French Minister of Public Works and Transport, was attended by delegations from seventeen countries, thereby establishing its international character, the only notable omission being the U.S.S.R., whose representatives failed to appear. The British delegation was led by Mr. C. T. Gardner, deputy director of canals, Ministry of Transport, and included Messrs. C. M. Marsh, engineer and manager, Weaver Navigation; H. B. Emley, C.M.G., general manager, Aire and Calder Navigation; A. C. Lisle, O.B.E., general manager, Sharpness Docks and Gloucester and Birmingham Navigation Coy.; Lt.-Col. G. L. Lyon, M.B.E., M.C., and W. Fraser, representing the National Association of Inland Waterway Carriers.

A number of Papers were read at the meetings, the principal speakers being Mr. Paul Zeis, United States Department of Commerce; M. G. Willems, Director General of Waterways, Belgium; M. L. Charbonnier, Transport Manager of the Belgium Waterways; M. Vonk, Director of the Ministry of Transport, Holland; M. S. Mutzner, Director of Waterways, Switzerland; Mr. W. Fraser, of the National Association of Inland Waterway Carriers; M. Peltier, Director of Waterways, France; and M. Pierre Brousse, Director-General of French Navigation on the Rhine.

Among the points emphasised by one of the speakers to show the importance of inland waterway traffic in France was the fact that in 1938, the French waterways conveyed to and from the Port of Paris, no less than 17,000,000 tons of goods, a figure which it was hoped would soon be regained. The obstacle in this, as in the case of other canals in France and the Netherlands, is the extensive damage done to embankments, bridges, etc., by the Germans, which is in course of being repaired as speedily as possible. The replacement and augmentation of the fleets of boats and barges is also receiving attention.

Editorial Comments—continued

As some of the subjects discussed were of undoubted technical interest, as affecting the development of inland navigation in the various countries represented at the Conference, we hope to give further details in a future issue.

Indian Ports and their Future.

The statement in our Comment of last month on the Report of the Ports (Technical) Committee, that the present uncertain political situation in India is likely to jeopardise the country's port development programme, has been borne out by the announcement that British India is to be divided into two Dominions and that the Indian States of Hyderabad and Travancore have already declared their independence and other states are likely to follow their example. It therefore appears that the resolution passed by the Interim Government of India on 15th April last, accepting in general the recommendations of the Technical Committee is hardly likely to be implemented as it stands, although, no doubt, it will be duly considered by the new Dominions of India and Parkistan after they have assumed power on the 15th of this month.

It is to be hoped that agreement on a long-term nation-wide policy will be mutually arrived at, as it is an economic fact that the ports in India normally serve more than one province or state, so that agreements, whether on a regional basis, or to cover the policy of the country as a whole, are essential if development is to proceed on sound lines.

Already, however, differences of opinion have become apparent, and unfortunately, it now seems probable that the Dominions and independent states will work out port development plans in accordance with their own predilections.

With regard to the Report on the second term of reference of the Ports (Technical) Committee, details of which will be found elsewhere in this issue, the Interim Government have expressed their agreement with the principles which should govern the development of minor ports as set out by the Committee. They consider that the development of Bhatkal as a major port to serve the Mysore State requires further investigation, and as the minor port of Cocanada is less than 100 miles from the Port of Vizagapatam, they suggest, that for the present, the question of its further extension should be left in abeyance. In the case of the Port of Vizhinjam, there appears to be much conflict of opinion, and the Government of the State of Travancore have been requested to hold further consultations with the Cochin Government and other interested parties before proceeding with any large-scale development of a Travancore port.

In view of the complexity of the problems facing the new regimes, all who are interested in the future of India will wish them success in their endeavours to find a satisfactory solution, and hope that they will not allow mistrust and communal antipathies to warp their judgment, and that eventually, they will reach agreement on a programme of port development that will benefit the country as a whole.

Proposed Development of Portland Harbour, Australia.

Recent announcements in the Australian press that plans for the development of a deep-water harbour at Portland are under consideration by the Government of Victoria, draw attention to a project which has been a subject for controversy in Australia for the past sixty years or more.

From time to time, Portland Bay, an open roadstead on the coast of Western Victoria, 200 miles west of Melbourne, has been recommended as a site suitable for the construction of an artificial harbour, and many schemes have been prepared and reports submitted, the first being written by Sir John Coode, as far back as 1879.

Although the desirability of improving the present limited accommodation for shipping has been admitted, no extensive construction works have been undertaken on the grounds that trade has never been sufficient to warrant the expense involved and that the present jetty is able to deal with all demands made upon it. In 1945, however, the Public Works Committee, when reporting upon the present shipping facilities at Portland, agreed that it would be advisable for a thorough investigation to be undertaken into the best means of improving the port. Accordingly, Mr. E. J. Buckton and Mr. A. G. Clark, of Messrs. Rendel, Palmer & Tritton, Consulting Engineers, London, England, were asked to carry out an official survey. After making a detailed inspection of the harbour and its environment, the Consulting Engineers issued an interim report in September last, but stated their recommendations were provisional and subject to modification.

There is no doubt that the greater part of the trade of Western Victoria would find its natural outlet at Portland Bay if suitable shipping and cargo-handling facilities were provided, as its hinterland includes some of the best and most productive regions in the State. Also, it is the only port available for large vessels along the whole of the coast between Melbourne and Adelaide, a distance of 500 miles.

At present, however, the harbour facilities are reported as being unsatisfactory. The jetty, which is exposed to swell, needs reconstructing and the berths and approaches need deepening. There are no road facilities at the jetty berths and the gradient of the railway approach to the jetty is unnecessarily steep.

It is understood a full report on the scheme, giving both short-term and long-term recommendations together with an estimate of the costs, has now been submitted by the Consulting Engineers to the Government of Victoria, and as the plans are likely to be of technical interest, we hope to publish further details at a later date.

Engineering and Marine Exhibition.

The Engineering and Marine Exhibition which is being held at Olympia, London, from August 28th to September 13th next, is a strong refutation of the suggestion that British industry—tied by crippling controls, shortages of raw materials, manpower and fuel—has neither the resilience nor the initiative to weather the international marketing storms.

This year's Exhibition embraces the whole of the Main Hall and National Halls at Olympia, together with their galleries—an increase of over 45% on the 1937 Exhibition. Every available square foot of this space is taken; mostly by firms who for years have been regular supporters of this leading British Exhibition. Also represented are many newer industries, whose advent is an index of the great increase in the trades ancillary to shipping and engineering. The general arrangement of the Show follows the long adopted practice of sectionalisation, but, whilst all the old sections are larger than before, the newer sections are equally well supported to the limits of the space available.

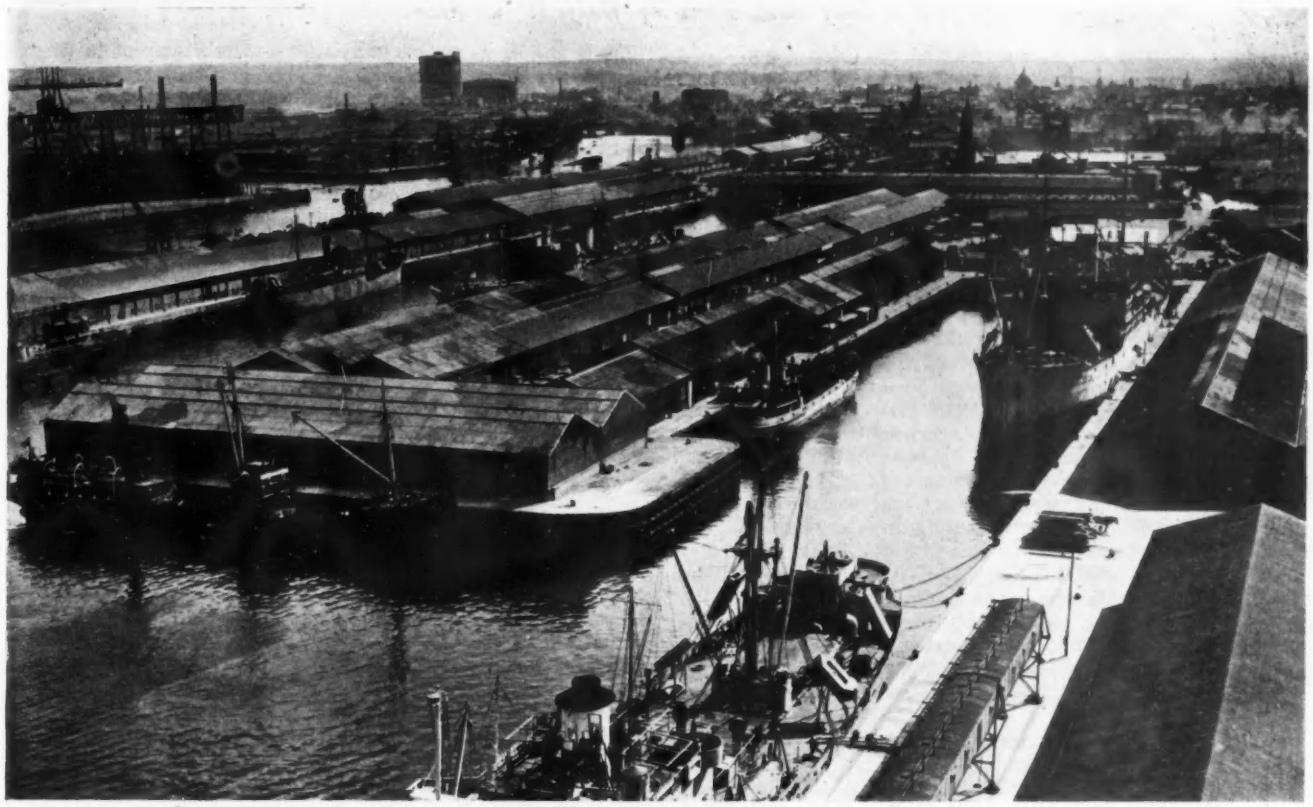
In the Foundry Section—a feature started some years before the war—the contrast between the production methods of pre-war and post-war eras will be clearly shown by the exhibits. The wide increase in the use of electricity and compressed air, and the improvements in lifting and shifting equipment, will tell their own story. The Welding Section, too, reflects the considerable advances which have been made in this most important sub-section of the engineering industry.

Of considerable technical and popular interest will be the demonstrations by divers of under-water metal-cutting by torch. A glass wall tank will facilitate close inspection of the methods employed, and the apparatus will be explained in detail by the exhibitors co-operating in this particular feature.

The public will be able to watch the reported progress of ships at sea by means of a shore-to-ship teleprinter service, and messages between visitors and their friends on the high seas will also be handled. Another demonstration of interest will be a Radar station, fully equipped with the most modern devices.

Ice Formation in Harbours.

Two Swedish engineers have recently put forward a plan for the prevention of ice formation in harbours. The apparatus they have devised consists, it is stated, of spaced conduits, with outlets through which warm water is discharged. Rising to the surface, this warm current causes ice to melt, or to be prevented from forming. The process is simple, but we imagine that to render it efficiently serviceable an extensive and costly installation would be required. Further developments must be awaited before the scheme can be considered practicable on a scale large enough to deal with the problem in harbours of any size.



Spencer Dock (foreground), Dufferin Dock (right), York Dock (left). and Victoria Channel beyond.

The Harbour and Port of Belfast

Review of a Century of Progress

History Prior to 1847

THE origin of the Port of Belfast may be assigned to the year 1613, when Belfast, reckoned at that time to have a population of about 500, was incorporated a Borough by a Charter which contained a provision that the freemen and their successors were to establish a wharf or quay upon the bay or creek of Belfast, and all merchants and other liege subjects were there to load and unload and to import and export their goods, paying the usual customs and duty. The river called the "Pearsat," "Farset" or Belfast River, flowed down what is now High Street, and it was at the junction of that river with the Lagan that the first quay was constructed. The actual date of its construction is not known but it may be assumed that it was made shortly after the granting of the Charter. It was evidently established before the year 1662 for in that year, the quay, by Order in Council, was formally made a landing place—this recognition of it by the Government being probably for Customs purposes.

In the year 1663, 29 vessels of a total tonnage of 1,100 tons were owned at Belfast. The ships varied in tonnage—the smallest being about 6 tons and the largest 200 tons, but the majority were about 40 tons each. Carrickfergus was of greater importance than Belfast until the middle of the 17th Century when the trade of Carrickfergus began to decline whilst that of Belfast steadily increased.

The control of the original quay seems to have been largely in the hands of the Lords of the Castle and the Sovereigns of Belfast, the Executive Officer being a Water Bailiff whose responsibilities were *inter alia* setting and keeping of perches on the river; collecting anchorage fees; keeping an account of vessels coming into the harbour, with particulars of cargoes; seeing that obstructions to navigation were removed and that rubbish and filth were not deposited in the harbour.

In 1675 the Town Corporation decided that, to meet the increasing trade and shipping, the old quay or wharf "be enlarged and built up upon the strand on the south side of the river." The river referred to is the Belfast River (not the Lagan) on the site of which the existing High Street stands.

Early in the 18th century, complaints as to the administration and management, with demands for additional accommodation, culminated in an effort by the Corporation to promote a Bill to enable them to levy rates on goods for the purpose of forming a fund for cleansing the dock and harbour and keeping the quay in repair. Owing to numerous disputes which ensued, this Bill never passed through Parliament, but the pressure seems to have been relieved to some extent by private enterprise—a quay called the "Hanover" quay having been constructed some time prior to 1720 by Isaac McCartney on reclaimed land, whilst other small private wharves were constructed later.

The next important step in the evolution of the Port occurred during the third year of the reign of George II, viz., in 1729, when the Irish Parliament, which had evidently been considering the condition of ports generally, passed an Act entitled "An Act for cleansing the Port, Harbours and Rivers to the City of Cork and of the towns of Galway, Sligo, Drogheda and Belfast, and for erecting a Ballast Office in the said City and each of the said towns." Cork at that time occupied a much larger place in the picture than Belfast. Whilst this Act may have been excellent in its intent, its scope was entirely inadequate for the achievement of any substantial results, inasmuch as it contained no provision

Harbour and Port of Belfast—continued

for the construction of quays or docks and the Corporation could do little beyond supplying ballast and keeping the channel clear.

In 1769, however, a new quay was constructed by Mr. Thomas Greg (not by the Dock Authority) on the north side of the river opposite the Hanover Quay on the south side of the river, which was built some time between 1716 and 1720. The new quay was named by Mr. Greg " Chichester Quay " in commemoration of the birth of Lord Chichester.

It was not until the year 1785 that the Irish Parliament passed an Act dealing specfically with the Port of Belfast. Under that Act a new body quite distinct from the municipality was constituted under the title of " The Corporation for preserving and improving the Port and Harbour of Belfast, popularly known as the " Ballast Board," which was endowed with certain elementary powers, e.g., to supply ships with ballast, to charge dues on ships, to licence pilots and appoint officers. The Ballast Board gave more attention to the deepening of the harbour, such as it was, than to the construction of quays and docks. Vessels drawing more than 10-ft. of water at neap tides, or more than 14-ft. at spring tides, were unable to come up to the wharf and were consequently obliged to discharge their cargoes into lighters at Garmoyle.

In 1796 the construction of the first Graving Dock of the Port was commenced on behalf of the " Ballast Board," by William Ritchie, who was also the pioneer of shipbuilding in Belfast. This graving dock was opened on the 1st January, 1800, and, in this, its 147th year, is still doing useful service for small craft. It is now known as " No. 1 Clarendon Graving Dock." Another graving dock, the present " No. 2 Clarendon Graving Dock," was opened in 1826.

The trade of the Port continued to expand as is evidenced by the fact that the Customs revenue which, in 1763, was £32,900, including excise, had risen, in 1813, to £393,512 excluding excise. The linen exported in 1690 was valued at £12,000, whilst in 1809, the exports of linen had increased in value to £1,910,909.

The Port although well established by the beginning of the 19th century was seriously handicapped by the natural difficulties presented by shallow water and a tortuous channel and by the inadequacy of its quays. The accommodation at the beginning of the 19th century apparently consisted of the Town Dock, Limekiln Dock and Ritchie's Dock, one or two private quays and the first little graving dock. In 1819 the first steamboat entered the Port —this was the *Rob Roy* which came from Scotland to trade between Belfast and Glasgow. The growing trade and the difficulties under which it was being conducted occasioned a great deal of thought and discussion, which culminated in the Acts of 1831 and 1837.

The Act of 1831 constituted a new Board, still under the old name, and empowered it to divert, deepen and improve the channel of the Lagan between the Long Bridge and the Pool of Garmoyle. The Act of 1837 again reconstituted the Board and conferred on it powers for the formation of a new cut or channel and for otherwise more effectually improving the Port and Harbour of Belfast. This marked one of the most important steps in the development of the Port and may be said to have provided the key to its entire subsequent development, inasmuch as the Act authorised the first serious attempt to overcome the natural obstacles to navigation in the form of the shallow and winding channel.

The first cut, commenced in 1839 and completed in 1841, eliminated the first bend of the river—simultaneously the portion of the river between the present Queen's Bridge, formerly known as the Long Bridge, and the new cut was deepened. The Board constituted under the Act of 1837 thus initiated the first step in a development which evolved eventually into the magnificent straight channel which now connects the Port with the deep waters of the Lough.

1847 Onwards

In June, 1847, the Belfast Harbour Act, repealing all previous Acts, was passed, constituting a new Body entitled " The Belfast Harbour Commissioners," with much more adequate powers for its work, e.g., authority to purchase lands, borrow money, carry out improvements, levy dues on goods and ships and appoint officers and pilots. This body with a membership of 15 (increased in 1883, to 21, together with the Mayor of Belfast as an ex-officio member) has continued to guide the destiny of the port for the last 100 years and is still carrying on with great force and vigour.

From the day on which they took charge, until the present time, they have never relaxed in their purpose of improving the Port and of keeping it abreast of the requirements of the times.

Two years after the constitution of this Board the second cut of the new channel, extending to Garmoyle, was opened in July, 1849, by Mr. William Pirrie, grandfather of the late Lord Pirrie and named " Victoria Channel " in honour of Her Majesty Queen Victoria.

From 1847 the development of the harbour proceeded practically without intermission. In 1848, three of the old artificial creeks or docks called the " Town Dock," " Limekiln Dock " and " Ritchie's Dock " were filled in. They have now become merely a memory.

About the same time the Donegall Quay was extended from 50-ft. to 150-ft. into the channel—the Queen's Quay on the opposite side from the Queen's Bridge to the first bend in the old channel being set back at a later date (1877) on an average of 250-ft.

In 1851 the Clarendon Dock, primarily intended for the foreign trade of that day, was formed and this dock is now used for the accommodation of small craft, its depth being only 10-ft. at low water

Under the Belfast Dock Act, 1854, the Harbour Commissioners were empowered to extend their property on the County Down side of the harbour and, at the same time, authorised to grant to the Corporation not less than 50 acres of land for the purposes of a public park to be called the " Victoria Park." This arrangement was duly carried out, except that the Harbour Commissioners increased the area to 60 acres, and the Victoria Park now forms one of the most valuable amenities of the City. When the subsequent reclamation of foreshore took place to the northward, the park unfortunately blocked the access thereto, so, by arrangement with the Corporation, the Board were enabled to make a roadway, 60-ft. wide, on the east side of the park, by which there is now an excellent approach to the reclaimed land. This road was subsequently handed over by the Commissioners to the Government of Northern Ireland and will form part of the new By-Pass Road to Holywood, which the Government are now constructing for the purpose of relieving the congestion on Newtonards Road.

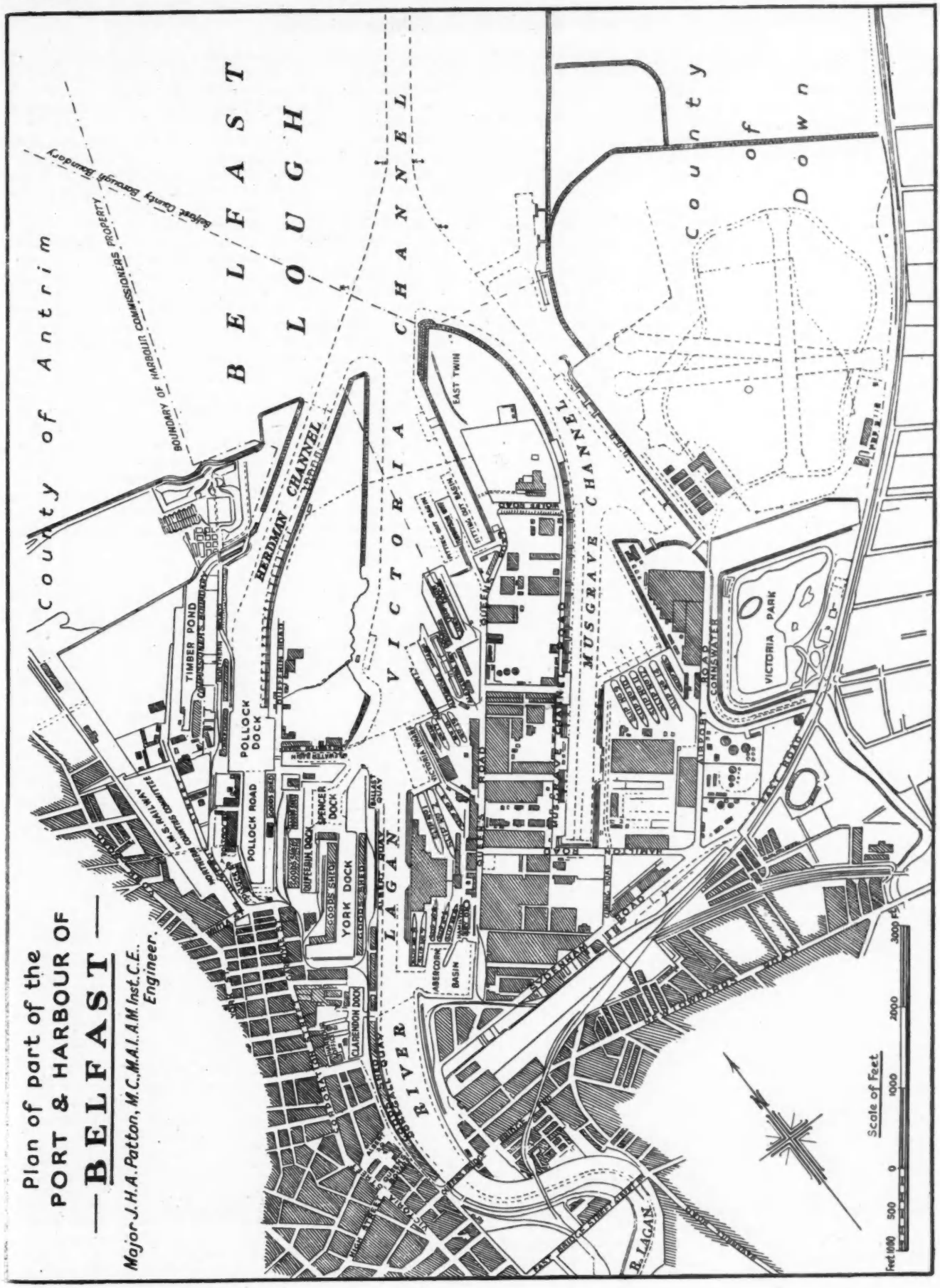
The Abercorn Basin and the Hamilton Graving Dock were opened in 1867 and named by His Excellency the Marquis of Abercorn, Lord Lieutenant of Ireland at that time—the Basin bearing his name and the Graving Dock that of Sir James Hamilton, the then Chairman of the Board.

Developments proceeded simultaneously on the County Antrim side of the river, the Dufferin and Spencer Docks (since much improved) being opened in 1872 by Earl Spencer, then Lord Lieutenant of Ireland, whilst the present Albert Quay, which is a continuation of the line of Donegall Quay, was opened in 1874.

In 1885 Their Royal Highnesses The Prince and Princess of Wales (the late King Edward VII and Queen Alexandra) and Prince Albert Victor, Duke of Clarence, visited the Port, and the Prince of Wales re-opened the Donegall Quay for traffic on the completion of its reconstruction. During the same visit, the Princess turned the first sod of the excavation for the new Graving Dock, which was opened in 1889 by His Royal Highness Prince Albert Victor, Duke of Clarence, who named it " Alexandra Graving Dock." The first vessel to enter the dock was the *Teutonic*, the longest vessel afloat at that time.

This graving dock did good service until the opening of the Thompson Graving Dock and for many years afterwards, but, owing to the gradual alteration in the sectional design of vessels to a flatter bottom, its usefulness became greatly restricted. The lower altarcourses were therefore cut away for a considerable portion of its length in 1932, so as to make its cross-section conform to that of the modern ship, and it then started on a new lease of usefulness.

In 1889 it was found that still more wet dock accommodation was required, and it was decided to construct a branch dock out


Plan of part of the
PORT & HARBOUR OF
— BELFAST —
Major J.H.A. Patton, M.C., M.A.I., A.M.Inst.C.E.,
Engineer.
County of Antrim
County of Down
BELFAST LOUGH
VICTORIA CHANNEL
MUSGRAVE CHANNEL
LAGAN RIVER
BOUNDARY OF HARBOUR COMMISSIONERS PROPERTY
Belfast County Borough Boundary
HERDMAN CHANNEL
EAST TWIN
TIMBER POND
POLLOCK DOCK
POLLOCK ROAD
SPENCER DOCK
YORK DOCK
GOODS SHED
CLARENDON DOCK
ABERCORN BASIN
VICTORIA PARK
CONNSWATER
AIRPORT ROAD
EAST ROAD
DONEGALL QUAY
QUEEN'S QUAY
B. LAGAN
Scale of Feet
Feet 1000 500 0 1000 2000 3000 Ft.

Harbour and Port of Belfast—continued

of the Spencer Dock or Basin. This was put in hand and finished in 1894 and the new dock, together with an extension, was formally opened in September, 1897, by Their Royal Highnesses the Duke and Duchess of York (afterwards Their Majesties King George V and Queen Mary), the latter of whom named the dock "York Dock." The extension joined up with the then existing Prince's Dock, which is now known as York Branch Dock.

The York Dock system has done good service during its existence of 50 years, but its depth of 26-ft. at low water has on occasions in more recent years proved inadequate for some of the large trading ships which have come to the Port, and this inadequacy led to the improvement, in 1922 and 1923, of the Dufferin and Spencer Docks. The Dufferin Dock was originally constructed with entrance gates for the purpose of impounding the water at a constant level, but, as the tidal range at Belfast is comparatively small, it was found by experience, that gates were more of an impediment than an advantage. The Board, therefore, undertook a scheme of improvement by which the gates were removed and the west quays of the Dufferin and Spencer Docks reconstructed and joined into one line, giving a continuous quay over 1,300-ft. in length. The berths, as altered, were dredged to a depth of 30-ft. at low water. On the eastern side of the Dufferin Dock a berth 635-ft. in length, was provided, dredged to a depth of 20-ft. at low water, and equipped with a modern shed.

The shed on the west side of Dufferin Dock was expanded to twice its original size and is one of the finest transit sheds in the British Isles.

Notwithstanding the additional accommodation provided up to 1897 the need for even more wet and dry dock accommodation was apparent and the Commissioners immediately set about obtaining Parliamentary powers to enable them to carry out further developments. At this stage one of the most notable controversies arose as to the direction which future development should take. The question as to whether such development should proceed on the County Down side of the river or on the County Antrim side gave rise to many warm debates, the then Chairman (Sir James Musgrave) with a number of Commissioners being strongly in favour of making a branch channel on the County Down side for the purpose of developing the Board's reclaimed lands. On the other hand, the late Mr. Samuel Lawther, together with other Commissioners, strongly advocated that the channel should be made on the County Antrim side. Another proposition which would have involved the building of two new docks at right angles to the river on the site of the existing Clarendon Dock and Graving Docks, was much discussed, but this latter scheme, though brought forward several times, did not find general support and was ultimately abandoned. The upshot of the controversy was the promotion of a Bill which became an Act of Parliament in 1898 giving authority for the following works:—

(1) The widening and deepening of the Victoria Channel,
(2) A new cut or channel (Musgrave Channel),
(3) A tidal dock at the termination of the new channel,
(4) Two new docks on the site of the Clarendon Dock and Graving Docks, and
(5) A Graving Dock on the County Down side.

The Musgrave Channel was proceeded with immediately after the passing of the Act. It was finished in 1903 and named "Musgrave Channel" in honour of the Chairman of that day. It was furnished with three quays and crane facilities, thus forming a large tidal dock capable of giving considerable accommodation for vessels.

The new Graving Dock was not proceeded with immediately, as the Commissioners, after visiting the principal ports of the British Isles, had come to the conclusion that something larger than their original proposal would be necessary to meet the requirements of the future. They accordingly sought further Parliamentary powers, as the result of which they were enabled to build the largest graving dock in the world at that time, which was completed in 1911 and opened by the largest vessel then afloat (the *Olympic*, 46,000 tons). It cost over £300,000 and was named "Thompson Graving Dock" in honour of the then Chairman, The Rt. Hon. Robert Thompson, D.L., M.P. The Thompson Graving Dock is still one of the largest in the British Isles, being 886½-ft. in length, 42½-in. in depth and having a width of 100-ft. on the floor.

The question as to whether further development should be on the County Down or the County Antrim side does not appear to have been entirely settled with the construction of the Musgrave Channel, and the ghost of the old controversy continued to haunt the harbour.

The Musgrave Channel was not developed to the extent provided by the Act inasmuch as the contemplated tidal dock at the southern extremity never materialised. It had often been said that the Musgrave Channel scheme failed to fulfil its purpose; that it had to be recognised that for trading purposes there has always been a bias towards the west side of the river. Whilst, however, the Musgrave Channel may not have developed in accordance with expectations, it must be admitted that it has justified itself in other ways, as subsequent developments show it has served a number of useful purposes which were not contemplated when the Channel was originally designed. A glance at the map of the harbour will show how it made possible the construction by Messrs. Harland & Wolff, Ltd., of their East Yard on land reclaimed by the Commissioners and, in 1922, the construction by the Commissioners of the Oil Jetty adjoining the reclaimed land. This jetty, which is used by the largest ocean-going tankers, has a berth 600-ft. in length, with 30-ft. of water at low tide. Concurrently with the establishment of the jetty the way was opened to the development of 30 acres of land on which the present installations for the storage and distribution of petroleum and petrol were established.

The Channel also made possible the establishment of the large electric power station of the Corporation. To serve this station the Harbour Commissioners constructed a special quay (No. 4 Quay), at which coal is landed from vessels and carried by mechanical conveyors from the ship's side right into the boiler house. This quay is now being extended by the Commissioners to meet the increasing requirements of the Power Station.

The Musgrave Channel also afforded access to the extensive sloblands and made possible their reclamation. Of this land 400 acres have been reclaimed to a height of 6-ft. above high water level, whilst a further area of 400 acres is in course of reclamation. The area already reclaimed was developed as an airport prior to the last war and was officially opened in March, 1938, by Mrs. Neville Chamberlain, wife of the Prime Minister of Great Britain at that time, and regular air services between Belfast and Great Britain and the Isle-of-Man were inaugurated.

On the outbreak of war the airport was requisitioned by the Air Ministry and since then has been in continuous use both by the Royal Air Force and by the Fleet Air Arm. It adjoins a deep-water berth and this enabled aircraft carriers, etc., to load and discharge their aircraft direct at the airport, a facility which was of inestimable advantage in connection with the Battle of the Atlantic.

It was hoped that, following the termination of hostilities, Belfast Harbour Airport would become the centre of civil aviation in Northern Ireland.

The airport is still held under requisition by the Air Ministry and scheduled air services were regularly operated from the airport until December, 1946, when they were transferred by the Ministry of Civil Aviation to the Government's Airport at Nutt's Corner. The Commissioners made strong, but unavailing representations to the Minister of Civil Aviation for the retention of the scheduled air services at Belfast Harbour Airport, in view of its proximity to the City and of the great service it was rendering to the general public.

The airport has, however, served a useful purpose as it made possible the development of regular services between Belfast and the other airports of the British Isles. It was also instrumental in setting up in Belfast the firm of Messrs. Short & Harland, Ltd., who, in 1936, established an aircraft factory on land adjoining the airport, thereby bringing this important industry to Northern Ireland.

Harbour and Port of Belfast—continued

The factory is so situated that aircraft constructed therein can be transferred to the airport by means of a bridge which connects the flying ground with the factory, and seaplanes can be launched from the factory direct into the waterways of Musgrave Channel.

It will thus be seen that the Musgrave Channel has abundantly justified its construction but obviously not in the way originally contemplated, and it was therefore inevitable that sooner or later further developments must take place on the County Antrim side of the harbour. For this latter development the Board exercised the comprehensive powers of their Act of 1918, and the ideas which had lain dormant since the inception of the Musgrave Channel materialised in the construction of a new dock system on the County Antrim side. This was carried through in two stages, one in 1933 and the other in 1943, the latter by the Board in collaboration with the Ministry of War Transport through the Government of Northern Ireland, enabling the Port thereby to meet the demands placed upon it by the exigencies of the war.

The first stage of the works was opened in October, 1933, by His Grace the Duke of Abercorn, K.G., K.P., then Governor of Northern Ireland, and the new works were named by H.R.H. The Princess Alice Countess of Athlone; the channel section being called " Herdman Channel " in honour of the then Chairman, Mr. (afterwards Sir Ernest Herdman, D.L., and the dock section " Pollock Dock " in honour of the late The Rt. Hon. H. M. Pollock, C.H., D.L., M.P., a former Chairman of the Harbour Board.

The water area comprised in the new channel, basin and docks was formed by dredging an area of over 80 acres through solid land and partly through shallow and obsolete timber ponds. Over 5½ million tons of material were raised by dredging plant and deposited on the sloblands in the vicinity of Sydenham, by this means adding upwards of 200 acres to the land area of the harbour and providing additional land for the construction of the airport.

The entire system of docks thus provided comprises:—

(1) An approach channel, 1¼ miles in length, opening out of the Victoria Channel in a south-westerly direction, and having a depth of 23-ft. at ordinary low water and 31-ft. at ordinary high water. The average width of the channel between high water marks is 435-ft. and at its full depth 230-ft.

It is lighted by means of electric flashing lights on either side.

(2) A turning basin of over 9 acres in extent, having 1,774 lineal feet of quayage with a depth of 23-ft. at ordinary low water and 31-ft. at ordinary high water.

A steel shed, 583-ft. long and 67½-ft. wide, has been provided on the West Quay.

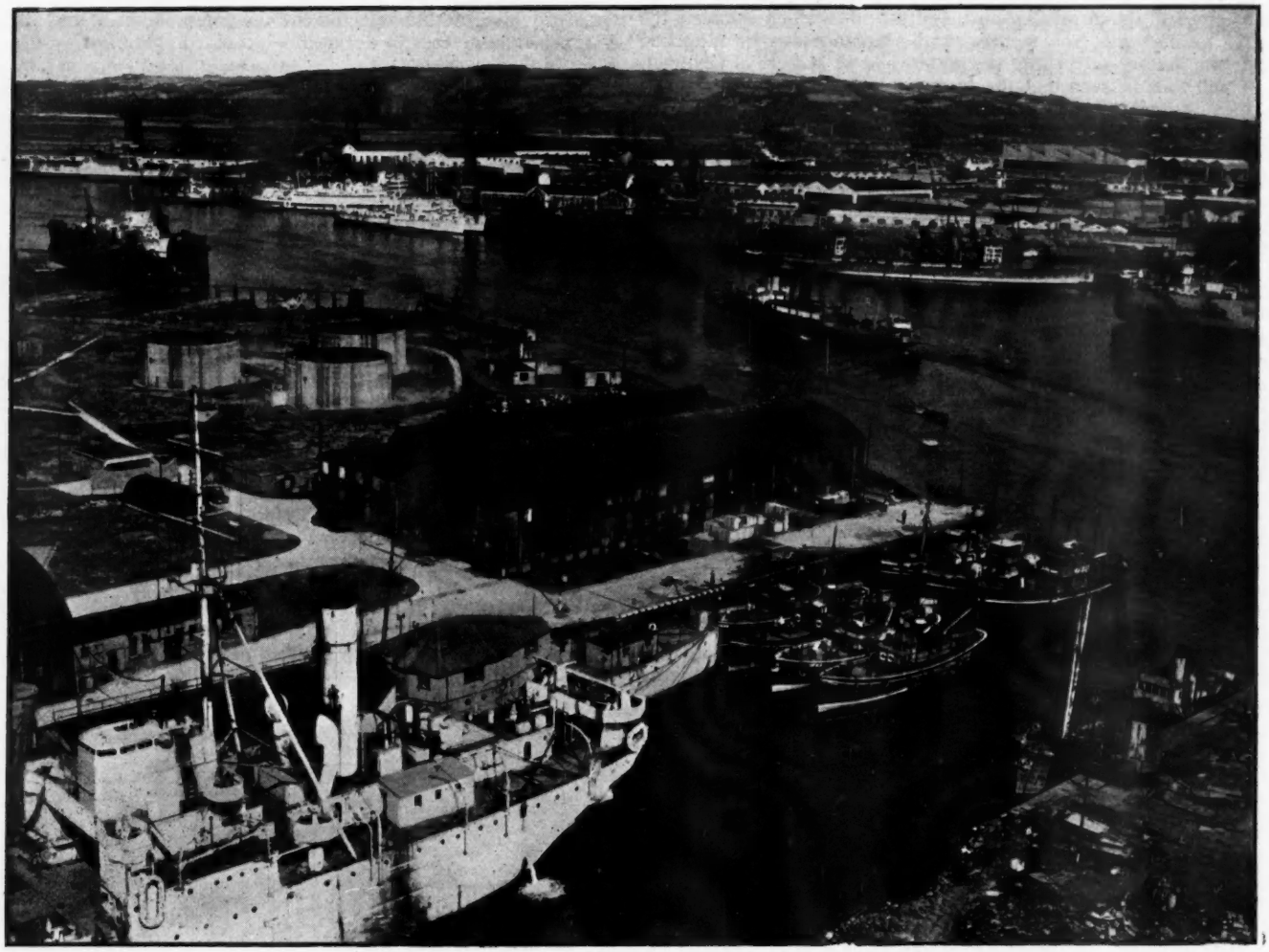
(3) A dock, 1,396-ft. in length, having 2,933 lineal feet of quayage with a depth of 30-ft. at ordinary low water and 38-ft. at ordinary high water.

A steel shed, 536-ft. long and 92-ft. wide, has been erected on the East Quay, whilst Messrs. Joseph Rank, Ltd., have erected a flour mill and silo on the West Quay, and Messrs. R. & H. Hall, Ltd., have erected a grain silo on the East Quay. These, in addition to the silo previously erected by Messrs. W. & R. Barnett, Ltd., on the West Quay of Spencer Dock, modernised the methods of grain discharge in the Port.

A shed, 495-ft. long and 120-ft. wide, has been erected on the West Quay, and another, 370-ft. long and 60-ft. wide, on the South-West Quay.

Messrs. Harland & Wolff's Ship-building Works at Belfast.

Harbour and Port of Belfast—continued



Victoria Channel, showing (in background) Fitting-out Wharves, etc.

The whole scheme is served by excellent roads and with railway lines connecting with the main systems of the three railway companies. The long, straight quays, the spacious docking accommodation and the broad channel leading from the sea form a fine example of modern harbour planning, whilst the flour mill and grain silos on the dockside and the new sheds and cranes complete a scene indicative of the potentialities of the vacant land in the vicinity as sites for industrial development.

Thhe foregoing briefly describes the physical evolution of the Port, and a careful look at the map shows what an excellent general design has resulted from that gradual process of evolution. It resembles Neptune's trident; the Victoria Channel forms the central prong of the trident; the Musgrave Channel opens out to the south-east and the Herdman Channel to the south-west, a design which not only affords considerable convenience but contains potentialities for future development when needed. The design enables waterborne traffic to be brought near to the City on three lines of approach, with the land communications interlocking with the waterways.

In 1943 the old buoys, which were fitted with acetylene gas or oil lamps and which marked the Victoria Channel, were removed and replaced by a modern system of electrically-operated beacons.

The activities of the port during the late war have been adequately described in the issue of this Journal for February, 1946, and need not be further detailed.

Shipbuilding at the Port

No account of the development of the Port of Belfast would be complete without reference to the shipbuilding, and to meet the requirements of the shipbuilding industry, the Port Authority has provided a number of wharves and jetties with deep water berths alongside for the special purpose of accommodating vessels which are fitting-out after having been launched, and those which are undergoing repairs. These wharves and jetties are named Thompson Wharf, Clarence Wharf, Alexandra Wharf, Alexandra Jetty and Victoria Wharf. In addition to the wharves and jetties referred to above, the quays and wharves of Musgrave Channel are now almost exclusively used by the industry for the fitting-out and repair of ships.

Queen's Island is the largest and perhaps the most self-contained shipbuilding yard in the world. It has been the birthplace of many ships, including famous passenger liners, e.g., "Oceanic," the first White Star liner to be built in Belfast in 1870, and superseded by a second vessel of that name; the "Majestic," "Teutonic," "Olympic," "Britannic," "Titanic" (White Star), "Alcantara," Almanzora," "Andes," "Asturias" (Royal Mail), "Stirling Castle," "Athlone Castle," "Capetown Castle" (Union Castle), and many others.

In later years the Queen's Island has established itself as builders of Naval vessels, e.g., H.M.S. "Belfast" (cruiser), H.M.S. "Penelope" (light cruiser), H.M.S. "Black Prince" (cruiser),

Harbour and Port of Belfast—continued

the aircraft carriers H.M.S. "Formidable," "Powerful," "Magnificent," "Eagle," and "Centaur," also H.M.C.S. "Ontario" (cruiser), and "Warrior" (aircraft carrier).

Trade of the Port

Year	Number and Tonnage of Vessels Cleared		Revenue from Rates on Vessels	Revenue from Rates on Goods	Revenue from other sources	Total Revenue from all sources
	Veasels	Tons				
1938 ...	7,247	4,544,612	105,507	114,635	110,722	330,864
1939 ...	7,342	4,480,434	101,619	118,863	121,352	341,834
1944 ...	9,299	4,669,516	114,702	175,063	228,189	517,954
1945 ...	10,735	4,534,723	106,923	162,409	210,110	479,442
1946 ...	8,176	4,083,496	113,716	166,487	245,842	526,045

Imports and Exports of Goods

Year	IMPORTS			EXPORTS			Total Imports and Exports
	Coastwise	Foreign	Total	Coastwise	Foreign	Total	
1938 ...	2,077,689	1,008,654	3,086,343	485,717	43,504	529,221	3,615,564
1939 ...	2,264,907	965,724	3,230,631	458,084	34,005	492,089	3,722,720
1944 ...	2,845,149	421,618	3,266,767	797,717	70,795	868,512	4,135,279
1945 ...	2,725,330	539,674	3,266,009	641,106	58,635	699,741	3,965,750
1946 ...	2,753,676	469,033	3,222,709	669,324	34,377	703,701	3,926,410

General Information

The area over which the Harbour Commissioners exercise jurisdiction as a Dock and Harbour Authority comprises the whole of that part of Belfast Lough which lies to the south of a line drawn from Carrickfergus to Grey Point, and extends to the lock and weir of the River Lagan at Stranmillis.

Out of harbour revenues the Harbour Commissioners maintain all the accommodation and facilities of the Port. They dredge, repair, light, cleanse, police and watch the whole of the Estate, both on land and sea, and carry on the general administration and management; they supply modern cranes, weighbridges and other facilities necessary to a port; they pay the annual interest on the monies borrowed for capital purposes; they set aside, without fail, the necessary actuarial contributions to their Sinking Funds, by means of which their borrowings will eventually be discharged; they provide for insurance, income-tax and municipal rates, and having done that, they always have been able to show a surplus, which is utilised for the purpose of effecting works of improvement for which no specific statutory authority has been obtained.

It should be pointed out that, prior to the war, transatlantic liners called in Belfast Lough to embark or disembark passengers. The vessels did not actually enter the Port and passengers were conveyed to and from the harbour by means of tender.

The vessels did not pay Harbour Rates and their tonnage, therefore, is not included in the returns of tonnage entering or leaving the Port.

In the year 1938 the tonnage of such vessels arriving in Belfast Lough was 2,427,864 net register tons and 8,386 passenger were embarked or disembarked.

A charge is levied on each passenger embarked and disembarked and the total amount of this charge is included in harbour revenues each year.

The Rehabilitation of French Ports

Steps taken since the Liberation of France

The terrible havoc wrought in the ports of France, both during the period of occupation by the Germans and especially at the time of their departure under pressure from the Allied Forces, is set out in considerable detail in a series of articles contained in the April, 1947, issue of the French Journal *Travaux*, from which the following summarised particulars are taken. The articles are 14 in number and they deal seriatim with all the major ports on the French seaboard—in the English Channel, along the Atlantic Coast and in the Lion Gulf.

Preceding the articles is a summarised introduction by M. E. Fischer, Inspector General of the "Pontes et Chaussées" and Director of Maritime Ports, in which he states that 50 per cent of the total length of quayage was either completely destroyed or seriously damaged; the locks, the graving docks and their pumping installations had been the object of systematic destruction and 70 per cent. of them were absolutely non-utilisable. Furthermore, 2,120 vessels and floating machines of every kind had been scuttled in the channels and alongside the principal works, rendering all navigation impossible. Such in brief was the picture presented on the morrow of the German evacuation, and it was estimated that the work of restoration would cost 75 milliards of francs, with requirements in the way of materials as follows: 700,000 tons of steelwork, 1,300,000 tons of cement and 240,000 cubic metres of timber.

Into this welter of havoc and destruction the Maritime Service of the "Ponts et Chaussées," the French State engineering department, plunged and set about the task of reconstruction so effectively that at no time have inadequate port capabilities checked the flow of importations.

One of the many difficulties encountered was the shortage of certain materials, and, in particular, the shortage of steel and iron, only one-third of the estimated requirements being available for ready use. In these circumstances, the technical staff had to seek alternative methods of construction. Steel sheet piling, for instance, had to be replaced by concrete and reinforced concrete. The large lock at Dunkirk, the side walls of which were to have been reconstructed in steel sheet piling, are actually being formed on a new system of concrete piles. This particular substitution has permitted a reduction from 4,000 to 2,500 tons in the quantity of ferrous material necessary for reinstating a work of special importance. Similarly, the substitution of caissons of reinforced concrete for steel sheet piling in the cofferdams at the temporary lock at Granville has effected a reduction from 1,400 tons to 300 tons in the quantity of steel required.

In certain cases, it has been possible to place orders abroad for metallic structures, which could not be made in France; notably, English workshops have supplied the floating caisson at the entrance to No. 7 Dry Dock at Havre (described in the July, 1947, issue of *The Dock and Harbour Authority*), lock gates for the Transatlantic service at the same port and other floating caissons and lock gates at Dieppe and Calais.

The main effort has been directed towards the restoration of the key works: the locks, clearance works, dry dock machinery, etc. The following table sets out under each category the works destroyed and since replaced in working condition:—

Nature of Work	In service in 1939	Intact at Liberation	Restored to good condition			In service 1st June, 1947
			Provisionally	Entirely	Total	
Locks	67	20	14	9	23	43
Clearance Works	119	42	28	14	42	84
Slipways	14	1	6	5	11	12
Dry Docks	36	9	7	9	16	25
Totals	236	72	55	37	92	164

As regards the quayage, the number of available berths, which was 1,100 before the war, was reduced to 295 at the end of 1944 and was raised successively to 628 at the 1st January, 1946, and to 770 at the 1st January, 1947. In terms of length, the total quayage before the war was 146,676 metres reduced to 60,374 metres at the time of the liberation and brought up to 88,000 metres at the 1st January, 1946, and to 99,200 metres at the 1st January, 1947.

Wreck Raising. At the date of the liberation it was reckoned that there were 2,720 wrecks of all kinds scattered along the littoral of Metropolitan France (naval ports, commercial ports and sea frontage). As regards those coming within the province of the Department of "Ponts et Chaussées," out of 2,120 wrecks of all sorts which obstructed approach channels and installations of commercial ports, 1,620 vessels were refloated, or dispersed, at January 1st, 1947. This operation corresponds to a tonnage of 319,447 at a total cost of 2,577,000,000 francs, and includes such important

Rehabilitation of French Ports—continued

items as 8 floating docks, 68 tugs, 15 gate caissons and 20 dredgers.

Dredging Service. The needs of the dredging service are of paramount importance and it was necessary to take immediate steps for the restoration or replacement of dredging units. It was accordingly necessary to place orders for 52 new craft, comprising 9 dredgers, 4 compressors, 6 tugs and 33 hoppers, which, however, on account of shortage of materials cannot be completely fulfilled before 1948. At the present time, the maritime ports have 45 dredgers available as against 77 in 1938 and 20 at the Liberation.

Working Equipment. Before the war the commercial ports of France had 1,964 land cranes and 310 floating cranes. Of these 5.5 per cent. were removed during the period of occupation by the Germans and Italians and in addition, enormous damage was inflicted on the remainder at the time of the evacuation so that only one-fifth of the pre-war equipment remained usable. The measures taken have raised the number of quay cranes in commission from 324 at the Liberation to 872 at the end of 1946.

Traffic. Finally, the effect of the various vicissitudes as reflected in terms of port traffic at a few of the leading ports has been as follows:—

PORT	Gross Mercantile Traffic 1938 Tons	Gross Mercantile Traffic 1946 Tons	Proportion of activity as compared with 1938
Dunkirk ...	4,244,600	73,000	.02
Calais ...	762,800	456,000	.59
Boulogne ...	1,091,300	328,200	.30
Le Havre ...	6,667,100	4,770,200	.71
Rouen ...	7,701,600	4,186,700	.54
Cherbourg ...	245,500	1,290,300	5.30
Nantes ...	2,583,000	918,100	.35
St. Nazaire ...	363,100	831,000	2.37
Bordeaux ...	4,144,000	2,756,400	.66
Marseilles ...	9,957,300	7,107,900	.71

War-Time Engineering Problems

Mulberry Harbours

By R. R. MINIKIN

On Friday, 6th June, the second anniversary of "D" day, a number of papers were read at a Conference of War-time Engineering held in the Institution of Civil Engineers. There were 7 papers in all, 4 of them dealing with the Mulberry breakwaters, and 3 with the details of the piers, roadways, etc. All were of great interest and brought into prominence the excellent organisation of effort and the fund of resource that is to be found among our technical experts. The subject matters were, during the war, all "Top Secret."

The operations of war usually provide unlimited funds and give an impetus to inventors that would not be forthcoming in peace. Inventions of the means of furthering a cause are not the prerogative of one class of individuals in the technical field, nor yet are they confined to people experienced in the particular subject. Whilst the heads of pyramids (organised divisions) may be expert and seek to organise policy and effort in the lower bases, they do not always fit in these lesser individuals in the order of their technical ability or competency. The heads always have the faith that that which is important will filter through to the apices. There is little that is unnatural in this attitude, but in the stress of war it has some curious anomalies, for it confines matters under "Secret" restrictions to a limited field where the best can seldom emerge.

This attitude was wittily described by Mr. Robert Lochner, M.B.E., who gave a paper, as a "departmental stress." However the papers that have interest to our purpose are the following:

"Model Experiments on different designs of Breakwater," by F. H. Todd, Ph.D., B.Sc.

"The 'Bombardon" Floating Breakwater, by Robert Lochner, M.B.E., A.M.I.E.E.; Oscar Faber, O.B.E., D.C.L., D.Sc., M.I.C.E.; W. G. Penney, O.B.E., F.R.S.

"The Lay-out, Assembly, and Behaviour of the Breakwaters at Arromanches Harbour" (Mulberry "B"), by John H. Jellett, O.B.E., M.A., M.I.C.E.

"Phœnix," by Cyril R. J. Wood, M.I.C.E.

Dr. Todd's paper dealt with model experiments in the Ship Division tank at Teddington. He outlines the behaviour of models, of various forms of fixed-to-earth walls, under wave action. Most of these walls were triangular in section and of curious impracticable construction. That he was instructed to investigate all and any form of wall no matter how novel or how complete an innovation is appreciated. The need of the time was vital and urgent, and that master of forthright and free-minded progress, Winston Churchill, had given definite orders that the whole scheme had to be solved without reference back. Notwithstanding this, much valuable time was wasted in exploring forms, which most practising maritime engineers, from their experience, could have shown to be useless.

The most successful of Dr. Todd's more readily constructed models, a triangular brushwood wall, was used for river training over 35 years ago; it acted well in shallow water but was useless in deep water. Again, the masterly researches of Brigadier Bagnold on Wave Action: Sainflow's analysis of the Clapotis; Rouville and Pétry's observations of Wave Action on the French Coast: the report on the failure of the Algiers Breakwater by M. Pierre Rénaud, were all available. Besides these, there exist many records of the essential characteristics of a successful protecting, or wave reducing, medium subject to the assault of storm waves. Unfortunately the experiments of Dr. Todd on breakwater models were directed into unproductive channels, as many designers apparently concentrated on the novel form rather than the exploitation of established facts.

The Division of the War Office responsible for the provision of the Mulberry; be it understood that it was a military operation and provision; called together a fairly large panel of Civil Engineers and Contractors to consider the report of the Ship Division (of which Dr. Todd is Principal Scientific Officer), on the tests. May be the multiplicity of counsels in such a large committee, or the urgency of the deliberations, or perhaps both, eventually resulted in the adoption of one of the most unwieldy forms of caisson, the "Phœnix," for the breakwater. That the code word "Phœnix," the fabulously beautiful bird of the East, should be applied to this clumsy and ill-adapted unit is whimsically curious!

Nevertheless, once the form of the unit had been decided on Dr. Todd proceeded with flotation stability, sinking and towing tests with expedition and ability. He was now in his own expert element and with his staff did fine work in the limited time at his disposal. The original designs of the "Phœnix" units were found to be unstable and on Dr. Todd's recommendation modifications were introduced. In spite of my contention that most of Dr. Todd's breakwater tests involved so much wasted time, two very important conclusions were obtained by him. They are, (a) a floating breakwater is useless unless it can remain at rest when subjected to wave assault: (b) The "breathing" of an elastic or flexible-sided breakwater is effective in the absorption of a part of the wave energy.

The conclusions are of particular interest as is shown by the succeeding paper on the "Bombardon" Floating Breakwater, the talented authors of which show enthusiasm and competency in deductive argument, and no little ability in mathematical resource; The preamble to the subject, however, does not convince the less academic, but more fully experienced harbour engineer, that the fundamentals of harbour work and sea action are fully appreciated. Their statement that "a complete and accurate theory of marine waves now exists" occasions some surprise. That we can with some probability approximate conditionally to certain limits is true, but he would be a bold engineer who would claim accuracy; the problems are much too complex. The failures of many well-designed substantial breakwaters, show that there are factors of sea behaviour which defy analysis. Some failures are condoned as the victims of extreme conditions, unforeseen and unforseeable; in fact, the authors themselves stress this point later, in connection with the actual wave height experienced on the floating breakwater before it collapsed.

The highly complex systems of marine waves in the shallower waters of a coast do not lend themselves to mathematical treat-

War-Time Engineering Problems—continued

ment, nor can all the factors be verified. There will always be an unknown. The most we can claim is that we have good and serviceable working rules showing the tendencies of marine waves under varied conditions.

The authors in their argument upon the function of breakwaters assert that the waves are relatively skin deep. This is only true for deep sea waves and does not apply in the relatively shallow waters of a coast such as the Normandy beaches. Even in places like Alderney where the breakwater is constructed, at the deepest section, in over 100-ft. depth of water, there is evidence that wave action is felt on the sea bed. It is also established by many authoritative observations, notably the Dutch Rijkswaterstaat, and Professor Zenkovich, that the progress of the mobile material on the sea bed from which the littoral drift inshore is fed during gales, owes its forward movement mostly to wave action and its distribution to tidal current.

The authors in referring to a fetch of " unobstructed water some thousands of miles in extent " raise a point which I thought was settled some years ago. Dr. Scoresby found that Stevenson's rule for wave height and fetch held tolerably good for fetches up to 900 miles. Dr. Cornish, in confirming this further added that 900 miles appeared to be the limit to which a fetch could be reckoned. It is not entirely the great length of geographical exposure that influences the height of waves, so much as the direction taken by the travelling cyclonic depression: that is, the quadrant in which the gale reaches its maximum, where wind and wave follow the same direction. In other words, the line of greatest fetch does not always produce the highest waves unless it coincides with the right-hand quadrant of a travelling cyclonic centre.

I do not share the optimism of the authors when they assert that " the engineer may, if he so desires, arrive at an exact estimate of the characteristics of the sea he may expect to experience." Most engineers strive to be exact, and first of all in the collection of the data upon which to base their computations.

The very confident claim of the authors that floating breakwaters can be made as efficient as solid fixed-to-earth walls is very intriguing, and further information upon the tests which led them to this conclusion would be welcomed. When, however, they say that a great deal of the material in a solid wall breakwater, as usually constructed, from the point of view of reflecting wave energy is wasted, one is impelled to search their argument for the justification of such a statement. The reason they give is that the energy of gravitational waves is concentrated in the upper layer and that a reflecting wall to be effective need only descend to a depth below sea level equal to about 15 to 20% of the wave length. I can imagine most harbour engineers wondering how such a statement could creep into an expert dissertation upon breakwaters, for is it not a fact that most solid breakwaters, with few exceptions, are constructed in water, even at the pier heads, well short of this figure? Again it should not be forgotten that the greater part of the length of a breakwater is in water shallowing to zero; where breaking waves are the dominant factor of the design. In such situations a floating breakwater would not last one short gale.

It would appear from the author's theory, that the sand banks, pushed forward over the sea bed by wave action where the loose upper particles are carried forward by the tidal current, would be halted at the breakwater. But since the tidal current of greater intensity would still pass under the breakwater the finer particles would be carried into the quieter water of the harbour lee and there deposited. This would entail a heavy dredging programme and the harbour entrance would be a continual source of trouble, as it would be impossible to take advantage of the tidal range, inflow and outflow, to preserve the navigable channel.

The authors quote the official report of full-scale tests giving a measured reduction of 50% for the height of waves. At what point in the lee of the breakwater was this measured and what was the area covered by this reduction?

When in the course of my duties, as an officer of the Civil Engineer-in-Chief's department of the Admiralty I assisted in the scheming of the Mulberry Harbour, I endeavoured to compute the screening effect of a narrow straight solid obstruction down to sea bed. I utilised the data, on wave reduction experiments, of M. François Beau, carried out at Le Havre in 1938: the data on wave reduction of the Vizagapatam dredging mole, and the collected data of ranging in home harbours. From a graph compiled with the help of these full scale measurements I derived a formula which showed that in the lee of a straight line mole the waves reformed to full original height at a distance to the leeward equal to the projected length ot the breakwater on the line of the attacking sea. The screened area was tongue-shaped and had troubled waters of progressively increasing wave height from the wall. The area enclosed by a 50% reduction was no greater than $l^2/_8$ where l = the projected length of breakwater. At no point in the area was there calm water.

In view of the fact that the floating breakwater units of " Bombardon " were 200-ft. long with gaps of 50-ft. between them, it is regrettable that no measured record of the position and extent of wave reduction was obtained.

Nature provides us with two examples only of floating breakwaters. They are icebergs and floating masses of tropical vegetation. In both cases the masses are enormous, covering a large sea area and several wave lengths, so that relative to the sea they are rigid. However their life is short.

In the early experiments of the floating breakwater huge flexible-sided-rubberised sausage-shaped and bottom-weighted vessels were used, and the authors found that the flexibility of the sides assisted in the absorption of wave energy. Comparing this fact with a similar conclusion on the part of Dr. Todd in his tests on the brushwood models, I feel that the authors have stumbled on a phenomenon that may be developed with advantage. Light flexible walled protection used in conjunction with earth or stone walls may minimise many of the ravages of the sea on protection walls on our East Coast, and the coasts of Holland.

This " Bombardon " paper, on the whole, deals with a pioneer excursion carried out with ability by the authors in what appears to be an unfamiliar sea, and leaves one unconvinced of the efficacy of a floating breakwater.

Mr. J. H. Jellett's paper on the lay-out and assembly of the fixed breakwater deals mainly with the line of the units, weather encountered, and method of placing.

My first association with the Mulberry B project was in November, 1943, by which time details of construction of the various units were well in hand. The line and location of the breakwaters was yet to be settled. Mulberry B was first proposed as a straight line mole, almost parallel to the coast in 5 fathoms of water at low tide. This form was considered by the Naval Authorities as the most suitable for access and egress. However, after investigating the probable screening, or wave reduction effect, to the lee, it was shown that the water would not only be too troubled for small craft but would endanger the functioning of the pier heads to the landing roadway. The contours of the sea bed in the area were only partially known; but as fresh soundings were taken, they were plotted and eventually a reasonable plan of the area was completed. Whilst it was known that the sea bed was shingle, the depth of shingle and the underlying stratum was unknown It was also known there was a strong easterly littoral drift. From the known locations of the rocky spurs on the beach it was surmised that the shingle bed lay on rock. Fortunately, this proved to be the case.

Eventually it was decided that the harbour should have two main entrances at least 600-ft. wide, one to the west and the other to the north-east, and a third entrance for smaller craft to the east. This decision determined the final shape. Two shore arms were then located to be constructed of the smaller " Phœnix " units. Then from a list giving particulars of available vessels to be used as blockships the line of the outer mole, in the rear of the Calvados shoal, was located as near as possible to the designed line of harbour. The major decision of the location of the line of the Mulberry B was that concerned with the blockships. It was seen that the wave screening effect of the Calvados Shoal would be of great assistance not only in the subsequent protection from northerly gales but would also give the safest location for the first sinkings. The storm of June 19th justified this decision.

(continued at foot of next page)

Notes of the Month

Salvage of Rhine Barges.

The Dutch Rhine Shipping Mission has raised 700 Dutch Rhine barges and other Dutch vessels since July, 1945. More than 70% of the vessels were found to be still serviceable. More than 100 vessels now remain to be salved, and the work is expected to take at least another year to complete.

Institute of Transport Endowment Fund.

In July, 1946, the Institute of Transport announced the inauguration of an endowment fund of £100,000 to provide the Institute with a building of its own. Up to date, some £60,000 has been subscribed, and the Institute have succeeded in securing suitable premises. An official announcement on the subject is expected to be made in the near future.

Electrification of Princes Dock, Glasgow.

At a meeting of the Clyde Navigation Trust held recently in Glasgow, the trustees signified their approval of the further electrification and improvement of the Prince's Dock scheme estimated to cost £1,000,000, on the understanding that its introduction either by stages, or as a whole, would be considered in the light of other improvement schemes already on hand, and other circumstances. It was also agreed that the annual inspection of the trust works and properties will take place on September 2nd next.

The U.S.A. to Build World's Largest Dredger.

The award of a contract to the Sun Shipbuilding and Dry Dock Company has been recommended by the United States Army Engineers at Philadelphia for the construction of a hopper type dredger, 500-ft. in length, 72-ft. beam and 40-ft. in depth. The vessel will have a capacity of 8,000 cub. yds. and will be the largest of her type in the world. The cost is estimated at $9,600,000 and the time required for construction is expected to be about two years.

Australian Coastline Survey.

Survey ships of the Royal Australian Navy are engaged on the charting of 15,000 miles of coastline around the Australian continent and adjacent territories. Three ships are operating, the sloop "Warrego" and the frigates "Lachlan" and "Barcoo." They have already charted the coastline and marked the depths, reefs, rocks and shoals, and other physical features off King Sound, on the West Australian Coast, some 600 miles south-west of Darwin, and will proceed to survey Spencer's Gulf in South Australia, working southward from Whyalia. So far, the surveys have located the wreck of a ship 300-ft. long, and also have discover a large, dangerous uncharted shoal on the West Australian Coast and an undersea canyon, on the South Australian Coast.

Echo Sounder Survey for Severn Bridge.

A preliminary survey by echo sounder has just been completed on the site of the proposed Severn Road bridge. The bridge which will have a centre span of 3,000 feet and an approach span of 1,000 feet, will be supported by steel cable carried by steel towers 450 feet high. The survey has been made in order that foundations may be designed for the concrete piers which will support the towers. The site for the piers on the north side of the river lies between high and low water-marks and presented few difficulties in surveying. On the south side, however, the pier site is well below water-mark. A launch fitted with echo sounding equipment spent a week in charting accurately an area 250 feet by 100 feet. The resulting charts give depth readings at 2½ feet intervals on parallel lines 10 feet apart covering the whole pier site. The bridge when completed will be the largest suspension bridge in Europe. The total length of the bridge and approach road on both side of the Severn estuary will be about 8 miles. The cost is expected to be £2½ million.

Bristol Docks Appointment.

Mr. Norman Alastair Matheson, at present harbour engineer to the Dundee Harbour Trust, has been appointed chief engineer of the Bristol Docks undertaking and will enter upon his new duties early in October next.

Royal Engineers Transportation Units.

The War Office announces that it is intended to form Transportation units of the Royal Engineers which will comprise Railway, Port Operating and Maintenance, and Inland Water Transport Units. These will be included in either the Supplementary Reserve or the Territorial Army. It is expected that these Transportation units will be formed in the comparatively near future, and intending volunteers for the Territorial Army with appropriate experience would therefore be well advised to await the publication of further information on this subject.

Durban Traffic Record.

It is reported that a large volume of traffic is at present passing through the Port of Durban. The peak year was 1936, when 6,058,237 tons of cargo was handled, and in 1946 the figure was 5,798,488 tons despite the shortage of railway wagons and locomotives in the Union of South Africa. Tonnages are being well maintained and there is every indication that the record figure for 1936 will be exceeded. The number of vessels using the port is below the pre-war average; this is due to some extent to war losses and also to the fact that the ships in service are on the average substantially larger than before the war. During 1946, Durban handled 61 per cent. of all the imports, exports and transhipment cargo throughout the Union.

Traffic Congestion at Birkenhead Docks.

Reference to traffic delays at the Birkenhead docks was made at a recent meeting of the Birkenhead Chamber of Commerce. It was stated that in order to relieve the congestion, the Manchester Chamber of Commerce has suggested that goods for export should be sent by barge to Birkenhead. The regional transport commissioner, in a letter, indicated that it was the intention to press for segregation of transport into separate queues for heavy, fine and small parcels, although it was realised that at some of the berths such a procedure might not be possible. With regard to the question of loading ships from barges there was uncertainty as to whether the goods for export would arrive at Birkenhead by rail or road and then be loaded into barges, and who would pay for the process. It was decided to leave the matter in abeyance and await further developments.

War-Time Engineering Problems

(*continued from previouse page*)

Then came the problem of the placing of the available "Phœnix" units in the outer mole. To the west the sea bed sloped steeply seawards but to the east it was fairly even until it approached the Calvados Shoal where it again sloped steeply.

In any structure the foundations are the key to stability and a real anxiety here was the effect of the increased intensity of the tidal current, the loose nature of the bed, the steeply sloping portions of the sea bed on which the units sat, the gaps between units and the swim ends of units. Investigation of these matters showed that some units would be precariously placed, particularly those near the entrances, for this reason it was decided to double bank those units forming the entrance heads. For the rest, the whole operation was in the nature of a gamble against the occurrence of bad conditions.

Considered as an engineering job the Mulberry Harbour will not bear examination, but as an organised feat of first-class seamanship, courage, and endeavour it will remain an outstanding achievement for all time.

PORT OPERATION

Part 3 (C) of a series of articles by A. H. J. BOWN, M.Inst.T., A.C.I.S. and Lt.-Col. C. A. DOVE, M.B.E., M.Inst.T.

(Continued from page 71)

Design and Layout (continued)

Special Berths

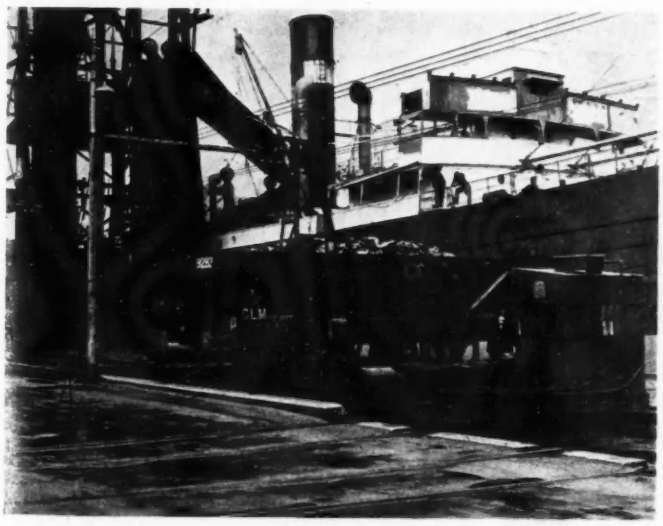
Specialised cargoes, such as coal, grain, petroleum products, frozen goods and live animals are usually handled at berths which have been particularly designed and equipped for the purpose. In most cases the layout of such berths has been influenced by the equipment used, and, for that reason the two aspects are considered together. It will not be possible in the space at our disposal to do more than touch briefly on some of the more salient features of some of them, but fuller information can be obtained in the books recommended for additional reading.

Coal

Coal is handled in a variety of ways including the use of hoists, staiths, conveyor belts, grabs, cranes and in some places, still, by hand. Practically all grades of coal lose quality by excessive breaking. In most ports therefore where mechanical means of handling are employed, " anti-breaking " devices are installed, if the coal is at all brittle, to minimise the amount of breakage.

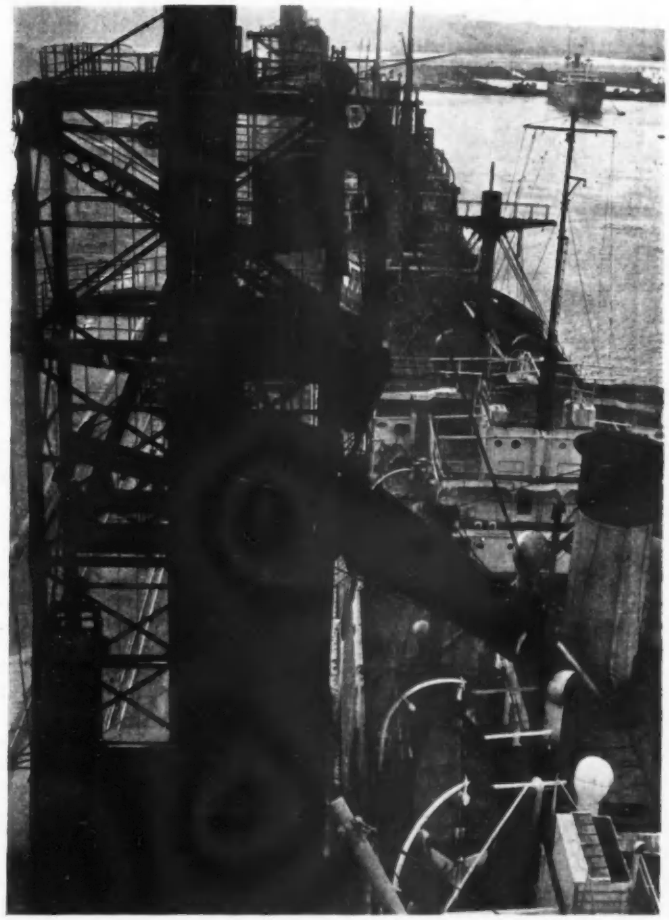
Hoists

Hoists are much used for the shipment of coal in the South Wales ports. They take the form of towers situated along the quay edge. Sometimes they are constructed to jut out at staggered distances from the quay edge into the dock water, which enables the vessels berthed at them to overlap in such a way as to increase the use made of the berths. These erections contain machinery for lifting railway wagons loaded with coal, one at a time, from quay level to a point above the hatch coaming level of ships berthed alongside. The hoist is fitted with a platform to which the wagon is clamped before hoisting. The platform can be tilted so that the coal in the wagon is tipped into a chute which delivers into the hold of the ship. The wagon is then returned by gravity to quay level. Sometimes the arrangements are reversed and the wagons are run by gravity to hatch coaming level and lowered by hoist to quay level. The approach railway roads to the hoist, and the return roads to the sorting sidings are sometimes gravity-operated in one direction only and sometimes in both directions.



[Photo by courtesy of Great Western Railway

Coal Hoist, Queen Alexandra Dock, Cardiff, showing (a), in foreground, two feeder roads for coal waggons leading at right angles to the traverser track; (b) a loaded coal waggon on the traverser moving along to the rear of the hoist; (c) hoist with empty waggon descending to quay level; (d) chute with anti-breakage device leading into ship's hold. The traverser is brought to rest at quay level (to the left of the figure 8 on the hoist) and the loaded waggon is then run end-on to the hoist platform and the empty waggon returned to the traverser.



[Photo by courtesy of Great Western Railway.

20-Ton Coal Shipping Hoists at Queen Alexandra Dock, Cardiff. Close-up of (a) the coal hoist, showing waggon, having been tipped end-on, returning to level position before descending to quay level; (b) the chute fitted with anti-breaking device. The traverser track can be seen at quay level running laterally behind the line of hoists.

To avoid warping ships during the course of loading, travelling hoists which can be moved along tracks from hold to hold have been installed at some modern berths in South Wales. These hoists are served by platforms which are designed to move wagons laterally between railway roads leading to and from the sidings and the hoists.

In the South Wales ports, before loaded wagons are placed under the hoist they are passed over a weighbridge, and the gross weight is recorded. After unloading, empty wagons are weighed on a separate weighbridge situated on the return road. By calculating the difference in the two recorded weights the actual weight of the coal loaded into the ship is ascertained. In other parts of the

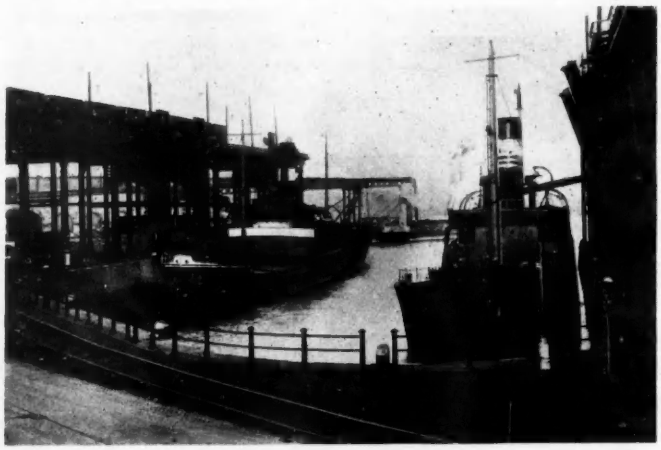
Port Operation—continued

country, Sunderland for example, where the collieries, generally speaking, are closer to the port, pit weights are accepted.

Where hoists are designed to handle coal wagons fitted with end doors, turn-tables are installed so that wagons with doors at one end only may be correctly positioned, where necessary, before being worked on to the hoist platform.

Staiths

Coal is loaded at some ports, notably on the north-east coast, from staiths. Staiths are piers built to or above ship's hatch coaming height alongside which ships may berth. The staiths



[Photo by courtesy of River Wear Commissioners

Coal Staiths at Sunderland. One chute in position to deliver on right. Hopper waggons on left.

are fed with railway wagons propelled by gravity. The common method of working is for the wagons to be run on to the staith and brought to a halt over a hopper which feeds a spout which delivers to the ship's hold. The wagons are fitted with bottom doors. When the wagon is over the hopper, the doors are released (by labourers known as teemers) and the coal passes through the hopper and the spout into the ship's hold. The doors are then closed and the wagon is returned under gravity along the " light road " to the " empty " siding for collection.

Conveyor Belts

Power-propelled conveyor belts are frequently used for coal loading. Usually the conveyor belt is fed at the landward end from a hopper, which is served by a wagon tipping platform to which the wagons are usually worked under gravity. At the ship end the conveyor shoots the coal into spouts which lead into the hold. One advantage of conveyor belts is that the quayside under the conveyor galleries can be put to good use as a storage or transit area.

Cranes, etc.

Grabs are sometimes used to load or discharge coal. In some places, they are fixed to high capacity travelling cranes; and in others, to travelling gantries, which in addition to moving parallel with the quay, run back for considerable distances thus covering a large stacking area as well as being able to plumb ships' holds.

In Calcutta a system of cranes and hoppers is used. The hoppers are lowered into trenches in the quay and filled with coal by hand, either from stack or direct from railway wagons. When filled, they are lifted by cranes into the holds of the ships, where the coal is discharged by means of a quick-release and anti-breakage device fixed to the bottom of the hopper. This method of coal handling is to be replaced eventually in Calcutta by hoists.

Grain

Special berths are used for handling bulk grain, but in this country they are generally designed so that they can be used for general cargo as well, if necessary.

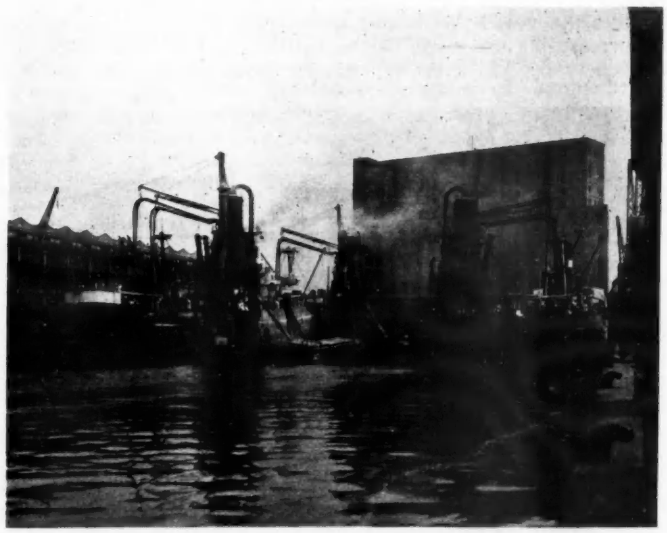
Bulk grain is normally discharged from ship by elevators which are of two types, the bucket elevator and the pneumatic suction. The second type, which is the more modern, is the one mainly used in this country. As its name implies it discharges grain from ships by drawing grain out of their holds by suction. Modern elevators are designed to weigh the grain at the same time. They may be designed as floating plant or land equipment. Either design can discharge grain ashore, the floating type being equipped with special pipes for this purpose.

The quays are laid out in the same way as ordinary general cargo berths for the direct delivery of grain, but in addition they are fitted with power-operated conveyor belts to carry the grain away to the granaries (bulk grain storage warehouses). The belt conveyors may be fitted above quay level as at Leith, or more generally, below quay level, as at Manchester. Where they are below the quay surface they run under a series of manholes through which the spouts from the elevator feed the grain on to the conveyor belt.

The grain is carried by means of the belts and elevators to the top of the granaries, where it is automatically weighed if necessary, and then distributed to the storage silos or bins (concrete compartments, which take the shape of inverted bottles, in which the grain is stored) in the granaries where it is held pending delivery. Granaries are usually road, rail and water served and bulk delivery is made to each of these forms of transport by means of spouts leading from the bottom of the bins to the delivery points outside the silo.

Arrangements are made to weigh and bag cargo if necessary in the course of delivery ex (from) granary.

A feature of modern silos is a thermometer room, where the temperature in any bin at any depth at any time of the day may be ascertained. (A similar device is used in modern cold stores.) Before the advent of this automatic recording device, the heat generated



[Photo by courtesy of Manchester Ship Canal Coy.

Discharging grain at Manchester by floating elevator to ship. These elevators can also be rigged to discharge grain to shore. Granary in background. Note bollards on right, set flush with quay and canted inwards.

in the bins was checked at certain periods each day by the use of a thermometer on a pole.

In grain exporting countries arrangements are made for loading ships direct from the silos.

Petroleum and Oils

The transportation of bulk petrol and oils from ship to storage tank and vice versa is carried out by means of pipe lines. In consequence it is not necessary to bring road or rail transport alongside the ship nor to make arrangements to stack cargo on the quay or in transit sheds as is the case with most other cargoes. As a

Port Operation—continued

result, berths for tankers are not the substantial quays equipped with transit sheds and heavy handling plant one associates with general cargo, but merely light open structures made sufficiently strong to carry the weight of the pipes and the pressure of ships alongside. (Even pumping apparatus is not generally located on the quay, but is installed in the tanker or the storage plant or refinery ashore.)

The handling of bulk petrol and similar highly inflammable liquids raises a problem in siting loading and discharging berths, owing to the grave risk of fire. The usual policy is to build them where possible, at considerable distances from the main dock system and on the seaward side. In London, for example, the nearest installations are at Purfleet, about 20 miles from London Bridge, in Calcutta they are situated at Bug Bug which is about 30 miles from the dock system; in Alexandria they are situated at an isolated berth about equi-distant between the main working parts of the harbour and within easy access of the open sea; in Suez, where there are considerable installations they are actually situated in a self-contained harbour completely segregated from the rest of the port. On the Manchester Ship Canal the problem has been tackled by building a special petroleum dock at Stanlow near Ellesmere with a boom across its entrance for the purpose of preventing the flow of oil out of the dock to reduce fire risk.

Part 4 (A): Cargo Handling

The study of cargo handling in port areas may be divided into three parts, (1) the means of cargo handling, i.e., ships' gear, cranes (shore or floating), cargo handling gear and such shore appliances as mobile cranes, runabouts, fork lift trucks and pilers; (2) the methods of working employed; (3) the documentation involved.

Means of Cargo Handling

The most important means of loading and discharging ships is by their own gear. Ships' gear is given this pride of place for the following reasons: (a) it makes the loading and discharging of ships possible in ports where there are no quay cranes, (b) it provides the only practical means of discharging or loading ordinary general cargo over-side when ships are not able to come alongside berths, (c) it renders the ship, for cargo working purposes, independent of power failures on shore, (d) it is often superior in lifting capacity to the average quay crane, and last, but not least important, (e) it has to be carried by the ship wherever she goes and should be used, therefore, as often as is economically possible, to compensate the ship owners for (1) the loss of freight space taken up by the ship's gear, (2) for the interest on the capital cost providing it and (3) maintenance costs.

For cargo handling purposes, ships' gear consists principally of (a) masts or samson posts. Masts are situated in the centre of the ship and where samson posts are used they are sited on each side of the ship, i.e., port (left-hand side facing the bow) and starboard (right-hand side facing the bow), (b) derricks (also known as booms), (c) winches, (d) blocks, (e) runners (also known as cargo falls), and (f) preventers. Some vessels are fitted with deck cranes instead of or as well as derricks.

Masts and Samson Posts

The purpose of the masts or samson posts for cargo handling purposes is to support the derricks, runners and blocks, when they are rigged, i.e., in position, for loading or discharging cargo. The masts are themselves supported by steel wire ropes known as stays and shrouds The stays run fore and aft and the shrouds athwartship. They form part of the ships "standing rigging." The number of masts on a modern power-driven ship depends mainly on the number of holds and hatches in the ship. A hold is a compartment in a ship provided for the carriage of cargo, a hatch is an aperture in the deck of a ship which gives access to the hold, through which cargo may be hoisted or lowered. In an ordinary 5-hatch cargo ship there are usually two masts, one between numbers 1 and 2 hatches and one between numbers 4 and 5. Number 3 hatch is usually situated in the waist of the ship, i.e., amidships, and for this reason is often hemmed in by superstructures which do not in many cases, leave sufficient room to accommodate derricks which would be long enough to plumb pitches either ashore or over-side from masts, which, as has already been explained, are situated in the centre of the ship. This difficulty is overcome by using samson posts, which since they are situated near the corners of the hatches instead of the centres, permit shorter derricks to be used. When samson posts are used, two are required, one for each side of the hatch. Some ships are designed with samson posts at all hatches. Some cargo vessels are constructed with three holds forward of the bridge and two aft. Most modern cargo ships are constructed so that the largest hatches are each provided with two masts, one at each end, this permits of additional purchases being rigged. Ships' holds are numbered from the bow of the ship (forward) to the stern of the ship (aft). In some ships the samson posts are built very high and joined in pairs by bars athwart the ship. This arrangement is known as the "goal-post" design.

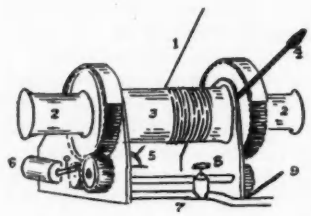
Derricks.

Derricks, usually two to each mast, are fixed to the mast or to a table at the base of the mast. The lower end of the derrick which is joined to the mast is known as the heel of the derrick. The actual joint connecting the derrick to the mast is known as the "goose-neck." The outer end of the derrick is known as the head of the derrick. The lower end of the derrick is joined to the mast at a point which will ensure that it is well clear of the ship's winches when in the lowered position. When a derrick is lowered, as is usually the case when the ship is at sea, the free end is supported in a form of cradle known as a "crutch," which word accurately describes its appearance which closely resembles a large surgical crutch. When a derrick is raised, in position for cargo handling, it is said to be "topped." It is held in position by a rope known as a topping lift, which is led from a "span" chain made fast to the deck, through a "span block" at the head of the mast, to the derrick head. The capacity of the derrick depends on the trade in which the ship is working, but the tendency on the average-sized 5-hatch cargo ship, is to construct derricks capable of handling loads of from 2½ up to 5 tons, according to the trade in which the vessel is engaged. It is not unusual to find a light derrick of say 2½ tons capacity fitted to the same mast and adjacent to a heavy derrick of say 10 tons capacity. Ships which are required to handle heavy lifts are commonly equipped with separate heavy lifting derricks (colloquially known as "jumbo" derricks) capable of making lifts up to 50 tons, although derricks capable of lifting very much greater weights are to be found on many ships. All ships' derricks should be marked with their safe working load (S.W.L.). In addition to the safe working load the length of derricks is important, for the longer they are the greater outreach they can command when loading or discharging cargo. The outreach of the derrick is the radius of the arc it would describe if rotated, i.e., the shortest distance between the heel of the derrick and the yardarm runner when it is in the lowered position.

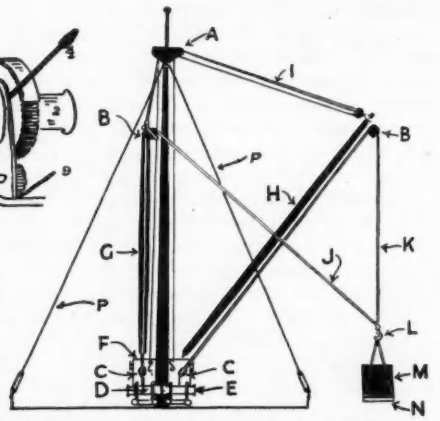
Winches

Winches are the machinery by means of which the runners are paid out or hauled in through the blocks (a form of pulley) attached to the masts and derricks. They are normally constructed with a rotating barrel divided into three separate parts, the centre part is known as the winch drum, and the other two parts on each side of it as the drum ends. Winches are usually provided one to each derrick and situated so that the winch drum is in line with the heel of the derrick. They are usually operated by steam, although electricity is being more and more used. The steam used for driving winches is known as "deck steam" and is generated quite separately from the steam used for turning the screws which drive the ship and is known as "main steam." Most winches are geared so that they can be driven in a high gear for light cargo and in a lower gear for heavier cargo. The main features of a steam winch are indicated in the sketch on the next page.

Port Operation—continued



Steam Winch (above): 1, Runner (led from heel block); 2, Winch drum ends; 3, Winch drum; 2 & 3, together referred to as winch barrel; 4, Reversing lever; 5, Gear lever; 6, Cylinder; 7, Steam pipe; 8, Steam valve; 9, Foot brake.



Union Purchase (athwart ship view—right): A—Cross Trees; B—Head Blocks; C—Heel Blocks; D—Winch Drum; E—Drum End; F—Mast Table; G—Derrick (inboard or midship); H—Derrick (outboard or yardarm); I—Topping Lift; J—Runner; L—Cargo Hook; M—Set; N—Cargo Tray; P—Shrouds (stays which are not shown in this view support the mast fore and aft).

Blocks

A block is a form of pulley through which a rope or ropes may be threaded or " reeved." It consists of an outer casing known as the shell, the two sides of which are called the cheeks. Inside the shell is a grooved wheel or wheels called sheeves over which the ropes or runners travel. The sheeves rotate round a pin fixed to the cheeks of the shell. They are made of hard wood for fibre ropes and of steel or some metal with similar properties for wire ropes. The space between the shell and the sheeve is known as the swallow.

Blocks may be described according to the functions they perform as will be explained, e.g., heel blocks, snatch blocks, and lead blocks or to the number of sheeves with which they are fitted, e.g., single block (one sheeve), double block (two), six-fold block (six). Blocks with more than one sheeve are described as multiple sheeve blocks.

The purpose of the multiple sheeve block is to permit of an increase in lifting capacity without using a runner of greater circumference. Any weight to be lifted must of course be within the safe working loads prescribed for the winches and the derricks. The student will appreciate that although a runner rove through a single block can be led direct to a cargo hook, this cannot be done with a runner rove through a multiple block. Accordingly cargo hooks fitted to blocks are provided for this purpose. Broadly speaking, lifting power increases in direct proportion to the number of sheeves employed, thus by using two single blocks instead of one, lifting power is doubled, if two 3-fold blocks were used the lifting power would be increased six times. This rough method of calculating the increase in lifting power does not take into account (1) the slight loss of power due to the friction introduced by each sheeve, nor (2) the additional increase in power produced when the upper block is the moving one, i.e., when the purchase is said to be " rove to advantage." A purchase or tackle is the name applied to a combination of blocks and ropes when they are arranged for lifting.

Runners

Runners or falls is the name given to the ropes with which masts and derricks are rigged for cargo handling purposes. For most purposes steel wire rope (S.W.R.) is used, although for certain types of rigs, fibre ropes (cordage) made of such substances as manilla, hemp or coir are necessary. The ships' gear is said to be rigged when it has been prepared for cargo handling, e.g., a derrick may be rigged for general cargo purposes by leading a runner through a block at the top of the derrick, through another block at the heel of the derrick, known as the heel block, or leading block, and on to the drum of the winch, to which it is fastened. The free end is fitted with the cargo hook. It can readily be understood that when the drum of the winch rotates in one direction the runner is wound round it, thus lifting the hook and the load (set) attached to it. When it rotates in the reverse direction it lowers the load. The drum ends can be made to rotate at the same time, and can thus be used for paying out or hauling in falls when certain rigs requiring the use of fibre ropes are being employed, as will be explained later.

Preventers

Preventers are ropes which are lead from the derrick heads and made fast to the deck or bulwarks of the ship for the purpose of providing additional stiffening when cargo is being worked.

The student will discover that the terms used to describe different parts of ships' gear vary between ports. The diagram on this page will assist him in following what has been said.

Rigs

Ships' gear can be rigged in a variety of ways to handle cargo according to the nature of the cargo and, of course, the preferences of the stevedores employed.

Union Purchase

The most common method used on vessels fitted with two derricks to each mast per hatch, is the union purchase, or married fall (known in America as burtoning). As its British names imply it is a method whereby both derricks are used. One derrick is rigged and fixed so that it is positioned with its head immediately over the hold (inboard or midships derrick), the other derrick is rigged and fixed with its head immediately over the ship's side (outboard or yardarm derrick), the loose ends of the two falls are joined to one hook or shackle, thus making one lifting unit or " purchase." It should be noted that the derricks are fixed so that they neither pivot nor move vertically. The fall on each derrick is operated by one winch manned by a winch-driver. As the derricks remain stationary when the set is being loaded or discharged both the vertical and horizontal movements of the cargo are brought about by the winch-drivers paying out or winding in the runners (according to whether they are lifting or lowering the cargo or moving it from hatch to pitch or vice-versa). It is obvious that the successful operation of union purchase depends on sound co-operation between the winch-drivers and the hatchway-man.

When the above-mentioned method is employed only one purchase can be used for each pair of derricks. It is possible, however, by using additional blocks on the derricks or on an additional stay led from the mast, to rig two union purchases from two derricks. For this arrangement it is necessary to work an inboard and an outboard operation from off each winch. Consequently this method of working necessitates the employment of three men on each winch, one driving the winch, one winding in or paying out by hand on one drum end, and the other doing the same on the other drum end (the winch drum is not used). It is obvious that since the handling of the rope has to be done by hand, wire would be unsuitable for this type of rig and accordingly cordage must be used. (In the case of ordinary union purchase either wire or cordage may be used, although in practice wire is almost invariably employed because of its greater strength in relation to its circumference). This method of working is popular where a homogeneous and comparatively easily-handled cargo, i.e., bales of cotton, is being worked from a hold large enough to permit of two gangs at a time to work.

It should be noted that in this rig and union purchase as both the derricks are fixed, the plumb of the derrick in the hold, or on the pitch to which the purchase is working, cannot be varied without topping (raising the derrick head) or lowering one or both derricks, which of course means stopping the work, even assuming that the normal obstructions to be found on a ship's deck will permit of alternative pathways for the sets.

Swinging Derrick

On ships with single derricks only on each mast per hatch, as is often the case with small vessels, the ordinary union purchase rig is not possible and the swinging derrick method is employed. This rig is also used on ordinary cargo vessels with two derricks per mast per hatch, when (1) it is desirable to use more than one pitch, (2) a fast-working light cargo is being loaded or discharged, (3) when extra outreach is required, (4) when it is necessary to work

Port Operation—continued

to both overside and ashore and quay cranes are not available, (5) when one winch or derrick breaks down.

The swinging derrick requires one derrick only for each hook. For most purposes, only one winch is used. This is required for the vertical movements of the cargo which by hauling in and paying out the runner raises and lowers the set. Unlike the union purchase method the derrick in this case swings on its heel from over the hatch to over the pitch. The swinging of the derrick and in consequence the horizontal movement of the load and the return of the empty hook is brought about either by (a) swinging the derrick over by power in which case two winches will be required, or by hand, the number of guymen required for this purpose depending on the weight of the set and the country in which the operation is taking place, or (b) listing the ship, in which case the set automatically swings towards the list. The light derrick is usually pulled back by hand but sometimes this is done by leading the runner through a block at the head of the mast and fastening a heavy weight on the end of it. This weight is known as the " dead man " and has the effect of automatically swinging a light derrick, i.e., one from which the set has been released, back into position for hooking on another set. This method is not generally popular owing to the danger of injury to personnel from the descending weight.

A swinging derrick which is entirely power-operated is often known as a " lazy guy."

Sometimes a single derrick is used to drag cargo up a skid placed from the dock to the ship's bulwarks. The cargo is hauled up the skid, which is placed so that the cargo swings over the square of the hatch when it leaves the skid. The empty runner and sling is taken down to the pitch by hand after each lift. This method is used for loading cotton and similar cargoes to small ships.

House Fall

In some ports, particularly in the U.S.A., handling gear is provided ashore in the form of masts, blocks, winches, etc., which can be " married " to i.e., rigged with ships' gear, for loading and discharging purposes, so that a union purchase is brought about by shackling a runner operated on the ship to a runner operated on the shore.

Jumbo Derrick

Before leaving the subject of ships' gear, reference must be made to the heavy lifting derrick, which has previously been referred to as the jumbo derrick. It is normally situated, where one is fitted, at the largest hatch. This is usually number 2. Where there are two such derricks, the second and generally smaller derrick is found at number 4. The heavy lifting derrick, like the swinging derrick, pivots on its heel, but owing both to the weight of the derrick and its loads, its movements must be power-operated and for this reason it requires three winches, one for hoisting and the others for controlling the lateral movements of the derrick. In addition, it is frequently found that the heavy lifting derrick requires to be topped or lowered during the course of the lift. Power for this operation is provided by using another winch. Thus when it is necessary to top the derrick during the course of a lift, four winches are required. For this reason four winches are fitted at hatches where jumbo derricks are constructed on some vessels. On many ships, however, winches from another hatch have to be used for providing power for the third and fourth movements. In calculating finishing times, the student should bear this latter point well in mind, for it means in practice that when heavy lifts are being made at one hatch work at the adjacent hatch may be stopped. For lifts by jumbo derricks multiple sheeve blocks are used.

Combination of Ships' Gear and Quay Cranes

Sometimes a combination of ship's gear and quay cranes is used, so that the ship's gear hoists the cargo from hold to deck where it is picked up by quay crane and placed ashore. The operation acts in reverse when ships are loading. It is claimed for this method, and generally conceded, that it is quicker, i.e., productive of more tons per hold per hour, than by using either ship's gear or quay cranes on their own, particularly where superstructures or rigging would impede or prevent a union purchase or a swinging derrick from functioning efficiently and quay cranes are of the fixed jib variety. One obvious drawback is that it requires, in the case of a union rig for example, one crane driver and two winch drivers instead of either one crane driver or two winch drivers. Where there are clear pathways for the sets and the hatches are not too small, it is usual to work alternate sets by crane and union purchase when both cranes and ship's gear are used.

The above descriptions of ships' gear set out briefly the main rigs used. They do not pretend to exhaust the subject, but they form the basis of the many variations to be found which differ according to the nature of the cargo being worked, the port or country in which the ship is being loaded or discharged, the type of purchase employed and the skill, experience and ingenuity of the operators.

(To be continued)

Additional Reading, as for Part 3 (c); also Nicholls's Seamanship and Nautical Knowledge—Brown; Chapter II, pages 26 to 33; Chapter III, page 41; Stowage Handling and Transport of Ship Cargoes—Garoche; Chapter III, pages 42 to 51.

Book Review

Screw Tug Design, by A. Caldwell, M.I.N.A., M.I.Mar.E., pp. 154, with illustrations, graphs and tables, price 18/- net. Published by Hutchinson's Scientific and Technical Publications, London.

Mr. Caldwell has the great advantage of having been concerned with the operation, design and construction of tugs for many years, and he has dealt with his subject in a manner which should appeal strongly to anyone connected with these interesting craft. He classifies tugs in four main categories: (1) ocean-going; (2) coastwise and estuary; (3) estuary and harbour, and (4) river and dock; Thames and canal.

The qualities demanded of the ocean-going tug are seaworthiness and long range, and the author gives an interesting comparison between a steam tug burning oil fuel and a tug propelled by Diesel engines. The range of the first would be 2,500 miles at 100 miles a day, and the range for the Diesel tug would be 4,500 miles at the same daily rate. The coastwise and estuary tug does not require the long range essential for an ocean-going vessel, but may nevertheless have to operate in heavy weather and must therefore be provided with ample food storage space and accommodation in case she is weather-bound. In the opinion of the author, the estuary and harbour tug presents the greatest problem for the designer, since her length must be sufficient to enable her to weather rough water in estuaries, yet every foot of length restricts her operation in harbour. Her normal service is assisting large vessels to dock and undock, and to attend upon them until they reach water where they can safely handle themselves. He rightly puts the Thames barge tug in a class by herself, for a very large proportion of the cargoes entering and leaving the Port of London is distributed and collected by barge and lighter, which may have to be towed as far east as the Medway or as far west as Brentford Docks. A Thames tug working from, say, Tilbury to Brentford or even to Fulham may drop and pick up barges at a dozen different places on the way, and very often she may have to select one barge from a mass of 30 or 40 in minimum time. She must therefore have ample power and be very handy.

Mr. Caldwell favours robust machinery of simple type for tug propulsion and it would be interesting to have his views on the relative merits of variable pitch as compared with fixed pitch propellers, a subject not touched upon in the book. It is instructive to read that tug owners on the Thames have found that Diesel tugs give about 16 per cent. more service than steam tugs, in spite of the " teething " troubles often encountered with oil engines

The author has set down the necessary calculations for tug design in a clear and simple manner and the book includes a number of extremely useful tables.

Railway Dry Docks

Their Characteristics, Construction and Limitations

By J. STUART CRANDALL, B.Sc., C.E.*

THE article on Marine Slipways by Mr. R. R. Minikin[1], and the subsequent one by Mr. W. Gordon Glover[2], which appeared in recent issues of the *Dock and Harbour Authority*, have been of considerable interest. In the latter, mention was made of railway dry docks, which have been developed in America by four generations of the Crandall family.

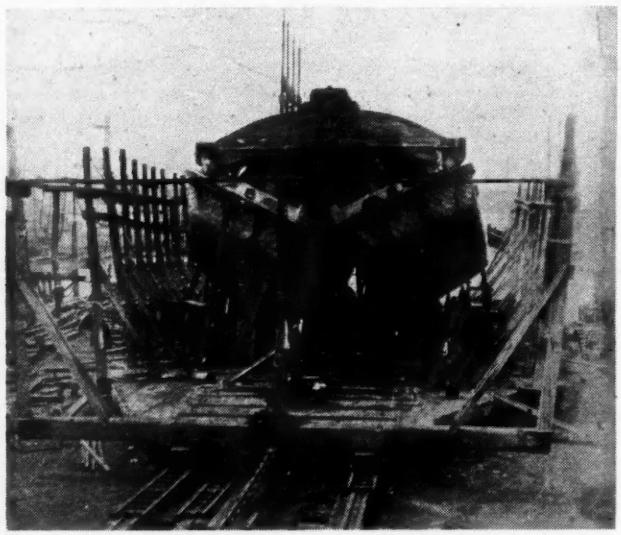


Fig. 1. 1,200 ton Railway Dry Dock as constructed in 1854.

Although these use the same fundamental principle of the inclined plane, they differ radically from the usual slipways, being in fact fully equipped dry docks operating on a sloping track structure. It is, therefore, the present purpose to give a more complete and accurate conception of railway dry docks, their construction and limitations.

Early Methods

When the earliest crude boat was hauled up a beach, it represented the initial use of the principle of the inclined plane to remove vessels from the water. As time went on and craft became heavier, crude windlasses were employed, and subsequently sliding ways were applied by the Phoenicians. The increasing application of science brought the adaptation of wheels and rollers and the utilisation of steam and electricity as motive power instead of men and horses. The railway dry dock is the result of progressive development and improvement of the primitive marine railway, which originated in America with the attempt to adapt launching ways for hauling vessels from the water on greased sliding ways. Later came the use of rollers operating between flat plates to reduce the friction and permit control of lowering as well as hauling.

Marine Railways

About 1840, William Hazard Crandall, who operated a shipyard at Newport, Rhode Island, constructed two marine railways which were so superior to previous ones that he was engaged to construct similar railways for others. In 1854, during the hey-day of the clipper ships, he was retained by a group of men in Boston, Massachusetts, to instal a marine railway at East Boston, to be of the then unprecedented capacity of 1,200 tons. One of his sons, Horace Irving Crandall, who was put in charge of the construction, persuaded the principals to incorporate several novel features, which resulted in marked improvement in construction and efficiency, thus creating what may be called the first railway dry dock. These improvements included building up the cradle at the after-end so that the slope of the line of keel blocks approximated that of the usual trim of vessels, increasing the height of the keel blocks, and placing a deck on the cradle, forming a platform with adequate space beneath the vessel to permit more efficient work at all stages of the tide. Previously men had to work from the ground, over and around the cradle beams. Another innovation was the use of docking platforms, supported by uprights fastened to the ends of the transverse beams, and above water when the cradle was lowered, enabling men to walk along them for handling lines in warping and centering vessels. (Fig. 1.) This railway dry dock, in the Atlantic Works Yard of the Bethlehem Steel Corp., is still operating after 92 years of service. Since that time, over 220 railway dry docks have been installed, with lifting capacities up to 5,000 tons. (Fig. 2.)

Rail Tracks

Tracks of railway dry docks are of the two-way type, for capacities up to 1,000 tons when the cradles are constructed of wood, and up to 2,500 tons when they are constructed of steel. The use of two-ways assures an even distribution of load to each way and its foundation. For greater capacity, the tracks are of the four-way type, with two heavy centre ways and two lighter lateral ones. Tracks are usually constructed on a uniform gradient of

Fig. 2. 5,000 ton Railway Dry Dock, Colonna's Shipyard, Norfolk, Virgina, Wood Cradle.

between 1 : 9 and 1 : 22, the slope selected being that which is best adapted to the natural bottom. Occasionally, due to space limitations, or the need of a horizontal deck for transferring vessels to the yard, as described later, the tracks are constructed on the vertical arc of a circle. The foundation of the track is usually of wood piling, cut off along the grade of the track by divers

*President and Chief Engineer, Crandall Dry Dock Engineers, Inc., Cambridge, Massachusetts, U.S.A.

[1] December, 1945. [2] September, 1946.

Railway Dry Docks—continued

using cutting templates which assure the same accuracy as if done in the dry. When the bottom is sufficiently hard, to assure no settlement under load, the tracks are supported by concrete footings.

The submerged portion of the track is constructed of wood and assembled as a unit ashore. (It is completely sheathed, to provide protection when marine borers are active.) Upon completion, this wood track is sunk on a previously prepared foundation, carefully aligned and then fastened in place by divers. The portion of the track above water is usually of reinforced concrete. One great advantage of this type of track construction is that it eliminates the great expense of a coffer dam and a second advantage is that, when the rail plates become worn after 25 or 30 years of service, the track may be readily lifted, re-railed and replaced at minimum cost.

Cradles

Cradles of railway dry docks usually consist of two or four longitudinal runners or girders, supporting the transverse beams. The cradle is equipped with sliding bilge blocks, supported by the transverse beams, and operated by chains and hand winches located along the docking platforms at each side. (Fig. 3.) The after end of the cradle is built up to form a general wedge shape, in order that the slope of the line of keel blocks may approximate that of the usual trim of vessels. By this means, a vessel is lifted on practically an even keel, avoiding the concentration of load on the forward keel block and transverse beam and along a considerable section of the track and its foundation, which Mr. Glover terms " sue." Furthermore, the cradle need not be hauled entirely clear of the water when dry docking a vessel, but only sufficiently to bring the deck a foot or so above water, when the entire bottom of the vessel is available for cleaning, painting and repairs. The deck of railway dry docks, being practically level with the yard and accessible on all sides to workmen and materials, permits operations to be carried out with the utmost despatch and economy. (Fig. 4.)

Normally, as stated, it is not necessary to haul the cradle entirely clear of the water, but this must be done from time to time to permit cleaning and painting the cradle structure and to make the rollers accessible at the after end. Where there is sufficient space to do so, this is accomplished by providing a light track extension inshore of the normal position of the cradle, designed to support the weight of the cradle only. In cases where this space is not available, it is customary to make the cradle in two sections, so that the forward section may be floated off and the lower one hauled clear of the water. (Fig. 5.)

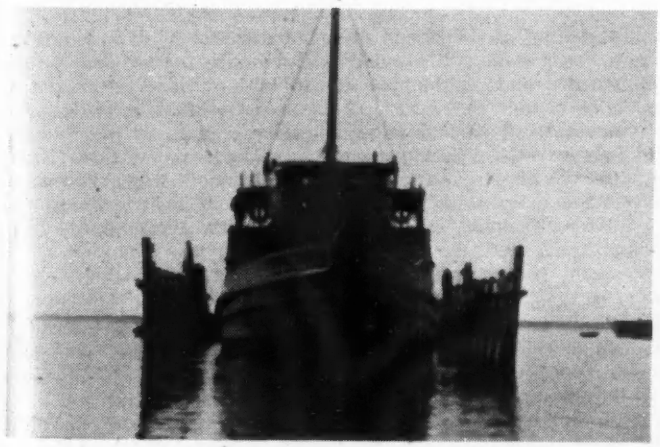


Fig. 3. Vessel entering 700 ton Railway Dry Dock, Kingston, Jamaica, Composite Cradle.

The use of telescoping cradles has never been considered practical for railway dry docks because the additional length required for a full-sized cradle represents little additional expense. Furthermore, when such a telescoping cradle is extended to full length, no support is provided for a vessel along the gaps between the several sections of the cradle, and this imposes heavier concentrated loads on the cradle sections, track and its foundation. In order to provide for dry docking two small vessels, as provided by the telescopic cradle, railway dry docks have been constructed with the cradle in two sections, so that a small vessel might be dry docked on the upper one and another on the lower one. The advantage of this is not as great as would appear superficially, because frequently the repairs to the vessel on the upper cradle are completed before the repairs to the vessel on the lower one, so that the upper vessel must wait, or both vessels be put overboard and the vessel on the lower cradle re-docked. Because of this disadvantage, in most cases the owners have coupled the two sections together permanently after a few years of operation. Therefore, the economic value of telescoping cradles is open to question.

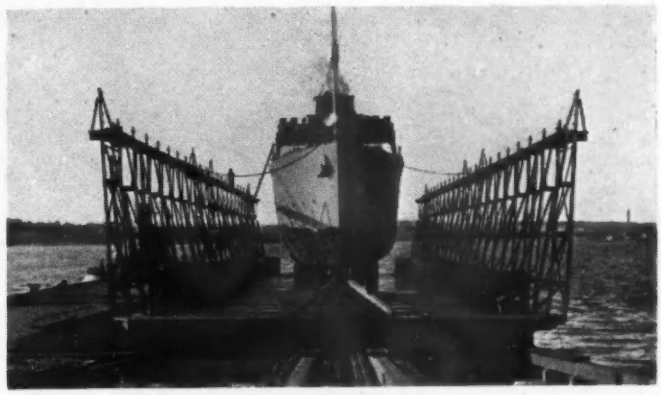


Fig. 4. 3,000 ton Railway Dry Dock, Sydney, Novia Scotia, Steel Cradle.

The cradle operates over free rollers of alloy iron or alloy steel, moving between the flat rail plates fastened to the lower surfaces of the cradle runners and the tops of the corresponding ways of the track. The use of high-carbon steel rail plates reduces the wear to a minimum and when these are of adequate thickness and properly fastened, any tendency for the ends to bend up is eliminated. These rollers are arranged in frames 10-ft. to 15-ft. long, which hold them rigidly in line at right angles to the axis of movement. This roller system minimises friction, eliminates the necessity of lubricating hundreds of bearings and of maintaining machined surfaces in sea water.

Hauling Gear

The cradle is operated by one, two, four, six or more hauling chains of heat-treated alloy cast steel, arranged on an endless system with smaller backing chains which pass through submerged sheaves attached to the track. These hauling chains pass around toothed chain wheels on the main shaft of the hauling machinery. With multiple hauling chains, the hauling and backing chains are attached to the cradle through a series of sheaves which function as an equalising mechanism in order that the load on all the chains may be the same. The principal function of the backing chain is to pull the lower end of the hauling chain downhill when the cradle is being hauled. Although the backing chain may act to pull the cradle down, under normal operation this is not its primary function; with the small amount of friction in the roller system, the cradle will move down the slope under its own weight. The hauling machinery consists of a train of gears connected to a steam engine, electric motor or other power unit. This chain haulage system has several distinct advantages, practical and economic. It is simple. The hauling chains, while being more expensive initially than wire rope, have a normal useful life of from 30 to 40 years, while wire rope must be renewed every ten years or so. Because of the fact that the moment arm of the applied load of

Railway Dry Docks—continued

Fig. 5. 1,000 ton and 500 ton Railway Dry Docks, Ostend, Belgium.

the chain on the chain wheel is very much smaller than the moment arm of the applied load of wire rope on its drum, the hauling machinery is a relatively small and inexpensive unit. For instance, the hauling machine for a 3,000 ton railway dry dock would weigh approximately 60,000 lbs., exclusive of the power unit. For a 1,000 ton railway dry dock, the usual hauling time is 16 minutes, requiring 100 h.p. For 2,000 tons, 20 minutes and 175 h.p.; for 3,000 tons, 30 minutes and 210 h.p.; and for 5,000 tons, 50 minutes and 240 h.p. For a 10,000 ton railway dry dock, with a hauling time of 60 minutes, 600 h.p. would be required.

Mention has been made of constructing the track on the vertical arc of a circle. When this is done, the bottom chord of the cradle runners are constructed on the same curvature, so that the line of keel blocks remains in a straight line, perpendicular to a radius of the arc. By the use of a curved track, it is possible to provide the desired depths of water over the keel blocks, fore and aft, when the cradle is in the outer position, and to have the cradle deck horizontal when in the inner position. Then, by using auxiliary cradles on the main cradle, vessels may be transferred longitudinally or laterally into the adjoining yard for extensive repairs, leaving the main cradle free for dry docking other vessels.

Side Haulage

Side haul railway dry docks are designed to meet conditions peculiar to navigable rivers. These are often subject to a wide range of water level with periods of low water lasting several months, interrupted by shorter periods of high water. Vessels plying such rivers are, of necessity, shallow draft, flat-bottom craft of light construction, which require dry docking facilities to be available at all stages of the river. To meet these conditions within the commonly available limits of space, side haul railway dry docks are constructed on relatively steep gradients and provide sufficient vertical movement to permit dry docking at all stages. They are usually constructed with several independent cradles and occasionally with a single cradle hauled by several independent parts of chain or wire rope. Inasmuch as it is fundamentally impossible to equalise the loads among the several parts, it is necessary that each be designed of sufficient strength for the heaviest possible imposed load. The result is comparatively high cost, about twice that of the end haul type. They are not particularly well adapted for ocean-going vessels; therefore, side haul railway dry docks should be installed only after careful study indicates that other types are not suitable.

Railway Dry Dock Capacities

Based on the fundamental conception of the railway dry dock, and applying the universal principles of applied science and engineering, there is actually no limit to the capacity which might be constructed. There are, however, certain practical and economic considerations which come into play. Railway dry docks, like slipways and basin docks, are fixtures at the site where constructed, while floating dry docks are relatively mobile units which may be readily moved to another location should economic or other conditions warrant it. Furthermore, as railway dry docks increase in capacity, their cost tends to approach that of floating dry docks, as shown by the following table, which is based on approximate current costs in the United States:—

Capacity.	Cost [Rly. Dry Docks.	Floating Dry Docks.]
1,000 tons	$120,000	—
2,000 "	$230,000	—
3,000 "	$340,000	$600,000
5,000 "	$500,000	$750,000
10,000 "	$900,000	$1,000,000

(For railway dry docks, a sinking fund established at a rate of 3 per cent. per annum provides an adequate amount for normal maintenance and repairs, and to amortise the investment at the end of 40 years. There are actually many railway dry docks over 40 years old and still operating at full capacity.)

Therefore, while from an engineering standpoint, there is no limit to the capacity of a railway dry dock, it is probable that economic and financial considerations would limit the practical size to 5,000-6,000 tons, except under particularly favourable conditions.

Radio Equipment for Docks and Harbours.

A new type of Marconi wireless equipment, a mobile very high frequency lightweight transmitting and receiving set was demonstrated recently in London. Although primarily designed for the equipping of mobile police units, the apparatus will be suitable for all types of mobile communication, including harbour and dock communications, fire-fighting services and all types of field operations, such as surveying, prospecting and field control. The equipment is already in use at the ports of Southampton and Middlesbrough, and plans have now been completed to instal sets in harbour craft at Liverpool, Swansea, Newcastle and Aberdeen. At the recent demonstration the clearness of quality of the voice at the transmitter and the total lack of interference were noticeable.

A Survey of Indian Ports

Technical Committee's Second Term of Reference*

(Continued from page 64)

The second term of reference of the Ports (Technical) Committee reads as under:—

"Whether there is justification for the conversion of any minor ports on the Coast of India to major ports, if so whether such conversion is practicable; also whether there are any other projects for construction of major ports which ought to be considered."

MAJOR AND MINOR PORTS

The distinction drawn between a "major" and a "minor" port is not mathematical: it is, in fact, purely arbitrary. If it were a matter of size or quantity of trade, Calicut, handling some 600,000 tons of cargo a year, would have been considered a major port before Chittagong. But wherever a minor port by reason of size or for some other reason is taken under the financial control of the Central Government, it becomes automatically a major port. Such major ports are Karachi, Bombay, Cochin, Madras, Vizagapatam, Calcutta and Chittagong. All the others are called minor ports, even Bhavnagar with 300,000 tons of cargo a year and Tuticorin with 500,000 tons and these come under the Provincial or State budgets.

For all practical purposes, the distinction between a major and a minor port is generally understood. The sheltered nature of a port, the well-laid-out approach channels, the provision of docks, jetties and moorings, the well-laid-out transit sheds, the effective railway connections, the ability to serve a very large portion of the hinterland lying behind the port, the comparatively large volume of traffic and the possibilities of working for shipping all the year round, usually distinguish the major from a minor port.

The ports in the Indian States do not come under the control either of the Central Government or the Provincial Governments. They are developed and managed by the Rulers of the States. The same considerations which we may apply in respect of the ports of British India may be equally applied, in the broader interests of India as a whole, to the ports in the Indian States.

The Committee's approach to its second term of reference can be best made through the ports of Kathiawar and the Indian States as the more difficult problems come from there.

Place of State Port Projects in Indian Trade.

Viewed from the all-India angle, the Sika, Veraval, Bhatkal and Vizhinjam projects have this in common, that they are the offspring not of the Central Government nor of a Provincial Government but of Indian States, though as will be explained in its proper place, Bhatkal actually lies within the Bombay province. In considering these projects the Committee has, therefore, borne in mind that the individual States interested may conceivably go ahead with their projects just as major ports in British India, for instance, Bombay and Calcutta have done or may be doing for reasons other than those which appeal principally to the Committee, to wit, economic reasons.

The Committee regards economic India as one geographical entity and is not interested primarily in the ambitions or prosperity of individual States or of individual ports in British India. It should not, therefore, be found fault with on the grounds that it takes a detached view of the three proposals; the new Port of Sika in Kathiawar (Jamnagar State); the development of the minor Port of Bhatkal on the West Coast, frankly intended for the use of the State of Mysore; and the proposed sheltered anchorage at Vizhinjam on the Coast of Travancore. The Committee asks itself the question not whether the particular project is of advantage to Jamnagar State or to Mysore or to Travancore as the case may be, but whether it fits in with an all-India scheme of economic development and progress; though it may be in an Indian State or in British India. As often happens, the answer in each case is not a clear affirmative nor a flat negative, but the Committee in its approach to each one of these projects has tried to keep before it the yard-stick by which all such planning should be measured, that is its service to the country as a whole. Judging from that point of view, the Committee feels a major port in the Gulf of Cutch between Karachi and Bombay is a necessity and considers in view of all the data that was placed before it that the Sika Scheme is a promising one.

The Problem of Customs Revenue.

It seems to the Committees uneconomic that the country's port policy, i.e., the siting of ports and their development, should in any way be affected by the claims of all-India Customs Revenue. Yet this question of Customs has loomed large in the history of Cochin, a major port, also in that of the Kathiawar ports, and will undoubtedly be brought to the front if the little harbour of Bhatkal materialises as a port for overseas trade. A settlement has been made at Cochin and the future history of the port may possibly be free of Customs trouble, but it is by no means sure that Customs policy will not affect the future of the Kathiawar Ports as it has affected their past. There is still vigorous disagreement between the Government of India and at least one of the Kathiawar States on the very question of division of Customs revenue.

The Committee would urge most strongly that this should not be; that no consideration of customs revenue collection should be allowed to influence the use of a port, its control and the routing of external and internal trade.

Natural advantages are fair enough; position on the coast in relation to centres of population, agriculture and industry, access from the sea, protection from weather, deep sea berths, all these are factors that should determine the siting of a port, but not the financial advantage of a Government or a State interested in revenue to fill its coffers. Competition should be conditioned by natural advantages and be found in methods of administration and in the provision of the most suitable facilities for trade; any Customs agreement which has the effect of diverting trade into unnatural channels is detrimental to the economic growth of the country as a whole.

Self-Sufficient Ports.

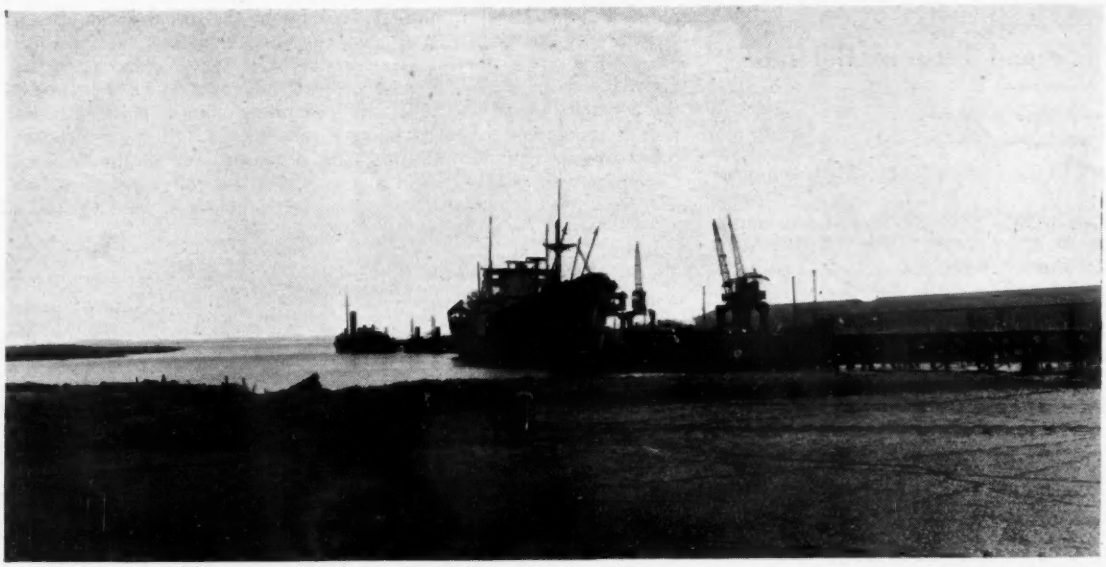
As a general rule, a port should be self-supporting. This may seem an obvious statement, but it is not easy to determine whether the existing ports either in British India or in Indian States are self-supporting or not. This economic aspect of the policy of port development must be essentially qualified by another one to the effect that a port is a long-term undertaking and therefore must be built and developed with an eye to the distant future. This dual aspect of the harbour policy is borne in mind in considering the various schemes that were placed before the Committee for its consideration. It is obvious that there must be some temptation to the Government of a State to use its port or ports to serve its own domestic ends and, if necessary, to support them out of State revenue. Ports in British India have also, in some cases, expanded themselves for reasons of a similar character. If ports are established or developed merely for the purpose of diverting cargoes from their most favourable economic channels, the Committee has no hesitation in saying that such a policy is not in the broad interests of the country. Trade for which a particular harbour is the natural outlet may easily be diverted to another harbour not so well suited if the latter by any means of a subsidy from General Revenue or by income which may be received from extraneous sources such as land or buildings can reduce charges to an uneconomic level and so artificially benefit the merchants importing or exporting those cargoes.

THE KATHIAWAR AND CUTCH PORTS

Bearing in mind the above three main considerations, the subordination of local gains to those of the country as a whole,

*Summarised Abstract of the Report prepared by the Ports (Technical) Committee and submitted to the Government of India in May 1946. A Summary of the Committee's recommendations was printed in the February 1947 issue of this Journal.

A Survey of Indian Ports—continued



Bhavnagar Basin and Jetty. An 8,000-ton ship alongside the concrete jetty, which is 880-ft. long.

secondly the advantages of genuine competition and thirdly the avoidance of uneconomic temptations, the Committee now proceeds to deal with the projects which have been specifically laid before it and begins with the Sika scheme.

Before coming to the scheme itself the geographical and political position of Sika in Kathiawar must be considered as well as a proportionate view of Kathiawar port problems. The Kathiawar coast forms a very small section of the sea outline of the Indian sub-continent and the only reason why it takes so large a part of our attention, apart from its internal complications, is its proximity to the important centres of Central and Upper India and its inability to take advantage of its geographical position owing to the Customs barrier of Viramgam. It is interesting to note that Navlakhi and Bhavnagar are less than 700 miles by rail from Delhi, while Bombay is 845 miles distant from Delhi and Karachi 907 The establishment, therefore, of first-class port in Kathiawar has much to recommend it geographically.

It is necessary first to describe the Kathiawar and Cutch Ports very briefly in order to get a balanced picture of their contribution to Indian trade and to understand how the introduction of Sika into the picture influences the whole design.

The Port of Bhavnagar in the Gulf of Cambay has an anchorage in the gulf; six miles from the anchorage is a small harbour accommodating two ships alongside a quay; and also a further six miles up a creek, a large lighterage and sailing vessel port. There is a serious dredging problem at the port and a 40-ft. range of tide which is a great handicap to port working. Export trade comprises oil seeds, cotton and grain and import trade wool, cloth, iron and timber.

Porbandar is an open roadstead on the West Coast of Kathiawar and is a lighterage port only.

Veraval is an open roadstead on the South-west Coast of Kathiawar and is a lighterage port only. It has sheltered accommodation for sailing vessels and has a scheme in view for a sheltered large-vessel anchorage with possible quays.

Port Okha. Just inside the north-west tip of Kathiawar, has one ship-quay berth and one mooring with lighter berths; it is distant three miles from the outer anchorage. There is a dredging problem. Export trade; salt, cement and oilseeds; imports are coal and oil

Bedi. On the north Coast of Kathiawar is a lighterage port only and is completely dry at low tide. The ship anchorage is six miles away. Export trade is in oil seeds, cotton, wool and salt; imports are rice, grain and sugar.

Navlakhi is a lighterage port only, 1½ miles from the ship anchorage. Export trade consists of oil seeds, cotton, grains and salt; imports of rice, iron and sugar.

The Committee was able to interview the representatives of seven Kathiawar States, including Cutch, which lies opposite the North Coast of Kathiawar on the other side of the Gulf of Cutch.

State	Port Concerned
Bhavnagar State	Bhavnagar
Porbandar State	Porbandar
Junagadh State	Veraval
Baroda State	Okha
Nawanagar State	Bedi
Morvi State	Navlakhi
Cutch State	Kandla

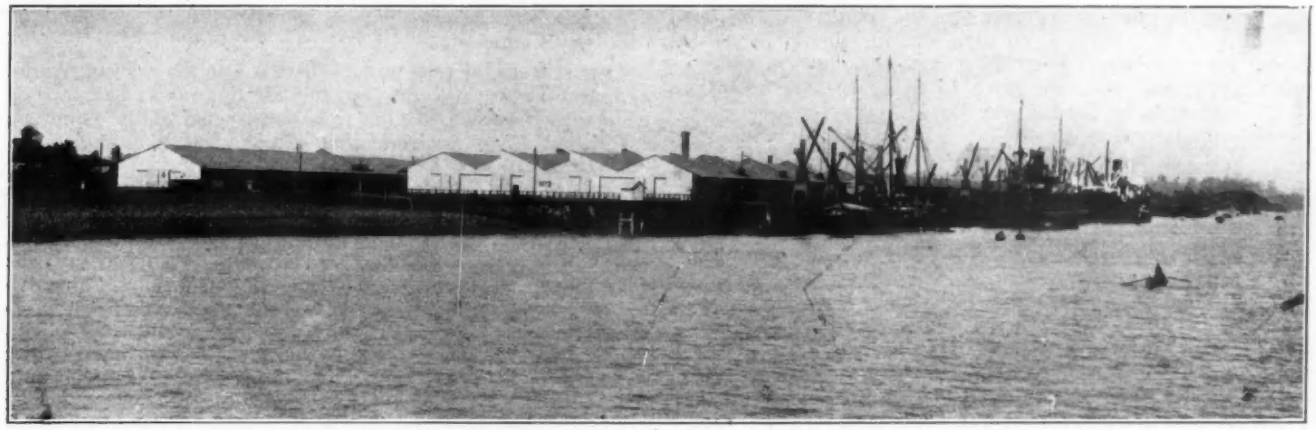
The representatives gave the Committee the following information:—

Port and State	Approx. Annual Tonnage of Cargo pre-war	Capacity in Tons of Cargo as at present designed	No. of Steamers (approx.)	Projected Works
Bhavnagar—Bhavnagar State...	300,000	5,600,000	270	New dredger. More lighters. One more jetty to enable port to take 4 ships and 1,000,000 tons of cargo a year.
Porbandar—Pordangar State...	185,000	370,000	261	Improve approaches, 10 more lighters (50 tons capacity each).
Veraval—Junagadh State ...	224,000	450,000	233	Protected Harbour for ships and ships quays,
Port Okha—Baroda State ...	274,000	400,000	119	Quay extension and dredging, New cranes, Target of 600,000 tons a year,
Bedi—Nawanager State...	200,000	650,000	Not given	
Navlakhi—Morvi State ...	200,000	500,000	163	Light the channel leading to the port and remove 2 small bars. 12 more cranes and increase port capacity to 700,000 tons,
Total	1,383,000	2,970,900		
Deduct Bedi figures		650,000		
Future capacity		2,320,000		
Add Siki replacing Bedi as Port for Nawanagar State ...		1,000,000		
		3,320,000		
Kandla—Cutch State ...	325,000	Not available	64	Can develop to meet trade requirements.

Whether or no the volume of trade passing through the Kathiawar ports will develop to the extent indicated in the figures shown in the third column above, it is difficult for the Committee to pre-

A Survey of Indian Ports—continued

diet. Without the addition of Sika, the traffic of Kathiawar ports, which stood pre-war at 1,383,000 tons, is expected to go up to 2,970,000 tons per annum. The favourable geographical position of the ports and their potentiality to serve the large hinterland lying behind Kathiawar will not, by themselves, be able to bring such a large expansion of maritime trade to Kathiawar. If anything likt the amount of 3,000,000 tons of traffic is to pass through Kathiawar, the Committee considers it its duty to point out that it will be hardly possible without a very large industrial expansion in that part of India. It may, therefore, be argued whether the creation of such increased port capacity and also the Sika scheme is justifiable on economic grounds. It should not, however, be forgotten that the creation of port capacity in excess of the immediate requirements of the trade is a vital aspect of a sound port policy and is followed by important major ports in British India.



Up-River View of the Port of Chittagong

Apart from this important aspect of port policy, there are other grounds in favour of the Sika Scheme, such as the quicker handling of cargo, and safer, cheaper working, proximity to Central and Upper India and the fulfilment of the need for a deep sheltered port between Karachi and Bombay. These considerations have therefore, largely influenced the recommendations which the Committee has made.

SIKA

Sika lies on the south side of the Gulf of Cutch in the State of Jamnagar, some 12 miles west of Bedi Port. There is a 2,000-ft. wide channel at this point, 36-ft. deep, with an easy entrance from the sea and affording reasonably good shelter.

The site was surveyed by the Admiralty so far back as 1851 and again by the Royal Navy in 1943. Acting on this latest survey it is now proposed to build on a reef on the west side of the Channel a ship-quay 1,300-ft. long with a water depth of 32-ft. at quay side. This quay will accommodate two ships of 500-ft. in length or alternatively three or more smaller vessels. Ship work at this quay has to cope with a 22-ft. rise and fall of tide. A lighterage wharf is to be built in continuation of this quay southwards to serve vessels lying at moorings in the channel close to the wharf. An oil berth is also contemplated and port workshops and future factories, all with water frontage. Land service is by metre-gauge railway to connect with the main line from Port Okha to Jamnagar, passing 15 miles away. The most costly part of the Scheme is likely to be the connection between quayside and railway layout. There appears to be no dredging problem. It is designed to handle about a million tons of traffic annually and is estimated to cost about Rs. 1,05,00,000.

In conclusion, the Committee is of the opinion that there is a need for a major port between Karachi and Bombay in the Gulf of Cutch and feels that, on the information at its disposal, with particular reference to surveys made and schemes in prospect, Sika is the most promising site for the purpose, and recommends that the necessary steps for the execution of such a scheme be taken. The Committee further suggests that with a view to providing effective and quick rail transport without transhipment to areas in Central and Upper India, on which traffic the port would need to depend largely for its economic prosperity, the laying of a broad gauge railway line from Sika to Viramgam or any other suitable station should form a part of the Scheme.

KANDLA

The Port of Kandla in Cutch presents a different problem altogether. Here we have a natural harbour to all intents and purposes as potentially promising as Sika. It has deep calm water approaches and no particular dredging problem. It is at least as near to the great cities of Central and Upper India as the ports across the Gulf of Cutch in Kathiawar; there are no constructional difficulties and the port already has a jetty alongside which only medium-sized ships can lie. Cutch, however, is cut off from the rest of India. The State has been slow to develop and is said to be markedly behind the times. This is as much due to its lack of enterprise according to modern standards as to its geographical isolation behind the Rann of Cutch, that peculiar desert sometimes dry, at times waterlogged, a desolate area, that stretches for 200 miles or so between the State and the rest of India. It has no road or rail connection with India.

The chief bar to its development as a Port of India would appear to be its geographically isolated position. Further, the State must give up its own currency which it still maintains and must come into Customs union or agreement with the Central Government. These are not matters within the scope of this Committee; we simply record them and note that a good natural port is waiting for the removal of these obstacles in order to become, so far as the Committee can judge, a useful and desirable addition to the ports of India.

VERAVAL

The only other scheme in Kathiawar for a ship harbour specifically referred to this Committee is that of the Junagadh State for its port at Veraval. This is an open roadstead on the south-west coast having a sheltered basin for sailing craft and lighters. The State proposes to convert this into a port affording sheltered anchorage and possibly later with quays for ocean- going steamers. At present the State is asking Government for help to get a Naval survey made of the port's possibilities. On figures shown to the Committee the port is now paying its way on a cargo of 220,000 tons a year, but whether it could do so as a fully-protected port is quite another matter. No engineering report has yet been made, and failing that, the Committee cannot usefully comment on the prospects of a deep sea harbour at Veraval.

OTHER PORTS

As shown in the statement above, other ports also have schemes for the future, not for deep-sea ports in particular, but for im-

A Survey of Indian Ports—continued

provement on their present lines; Okha for another quay, Bhavnagar for two more quays, Navlakhi for development as a most up-to-date lighterage harbour which it is already. But in considering all these schemes the Committee comes up against the same problem. Where is the traffic expected to make these schemes an economic success? It is not in the interests of India as a whole to encourage uneconomic schemes, and it is from the point of view of India as a whole that the Committee views Kathiawar.

Railways.

The Committee is not competent nor is it asked to discuss railways, but these have a bearing on the Kathiawar Ports as all ports are served by rail and in no other way. Roads are poorly developed and there are no inland waterways. The impression it gained, however, from discussions on the spot is that, so far as mileage goes, the railways are ample for the traffic, and no special expansion save in additional crossing stations should be needed for some years to come. For rolling stock the railways have the metre-gauge wagon pool on which to rely. In rate quotations they are controlled by the Railway Board.

At the same time it is very doubtful if the best use is made of the railways, and it is obvious that the complicated net work of lines in different States and the competing interests of the ports they serve cannot give an efficient and economic service to the maritime trade passing through this part of India. A bottle-neck at the Customs Barrier at Viramgam no doubt militates against the working of an efficient port policy. The mere removal of this barrier is not the only, nor indeed the first improvement that is to be sought. As already stated in a previous paragraph, the Government of India should assist the Indian States in the evolution of a unified port and railway system and should open the necessary conversations with them for that purpose.

BHATKAL

The Committee can best approach the problems of harbours in Indian States and British India with the assumption that such harbours are national harbours serving or intended to serve the country of India and in no way to be limited by political boundaries. It is on these lines that it takes up the Bhatkal proposal. If the hinterland of Bhatkal were British India and not an Indian State would a port at Bhatkal be regarded as a good economic proposition? If the Government of Mysore regard the opening of Bhatkal as a profitable paying concern should they not press the Government of India to open it up as a national port rather than prolong an unprofitable argument about jurisdiction?

The roadstead of Bhatkal lies on the West Coast of India some 300 miles south of Bombay, about 100 miles south of Mormugao and 300 miles north of Cochin. It is situated at the southernmost tip of the Bombay Presidency within 12 miles of the Madras Presidency to the south and 14 miles from the Mysore border to the east. At present it provides harbourage for small sailing craft, except in the monsoon when it is too exposed for an anchorage, and proposals have been made to locate a sheltered deep-sea port at this place.

Past History of the Scheme.

The possible development of Bhatkal into a deep-sea port has been under consideration by the Mysore Government since the year 1915 when Sir Francis Spring, late Chairman of the Madras Port Trust, made a first report on it. The Mysore Durbar also asked the Government of India for permission to extend the Shimoga branch of the Mysore Railway down to Bhatkal on the coast and to build a harbour there, jurisdiction and control of both railway extension and the harbour being ceded to the Mysore State. The latest engineering report that we have on the subject of the proposed port is one by Mr. A. G. Lyster, of the firm of Sir John Wolfe Barry, Lyster and Partners, made in December, 1919. Mr. Lyster produced schemes for separating the Bay of Bhatkal from the open sea by groynes and developing an inner creek known as the Sharabi river bed as a fully-protected harbour. This scheme was estimated to cost Rs. 144 lakhs and was expected to enable the proposed port when developed to deal annually with 2,300,000 tons of cargo. He also described another feasible scheme different in detail but not in essentials which would admit of better expansion but would be a good deal more costly. He considered that a first instalment of works for the former scheme could be initiated which would cost about Rs. one crore leaving room for future extension up to the above total figure of Rs. 1,14,400,000.

At that time, in the year 1919, it was estimated that trade amounting to about a million tons of cargo would be required to justify the expenditure of Rs. one crore, but unfortunately the latest traffic survey made in 1919 only promised about 200,000 tons a year. The scheme was therefore dropped in the year 1923 and was not revived until much later.

The project has now been re-opened by the Mysore Durbar and is one of the matters referred to the Ports Technical Committee for investigation and advice.

Railway Connection.

Apart from the port project there is also the railway required to connect the port with the Mysore State Railway at Talguppa on the Shimoga Branch. The line to be constructed will be 49 miles long, including a fairly severe ghat section, and is estimated to cost about 110 lakhs of rupees.

The General Manager of the Mysore Railway has estimated that, taking the port with the whole railway from Shimoga to Bhatkal, a distance of 111 miles, as one project, a return of 4% on the capital outlay can be expected, but it is difficult to say whether one should regard as one indivisible project a railway already constructed (that is from Shimoga to Talguppa) and a newly-proposed railway (Talguppa to Bhatkal) and port at the latter point now under consideration. Possibly the thought in his mind is that the railway line was extended from Shimoga to Talguppa with the eventual target of Bhatkal Port already in view, but it seems sounder to keep the future project quite distinct from the one already accomplished which must have had its own justification in the local traffic between Shimoga and Talguppa and the great hydro-electric scheme at Jog Falls.

Geographical Position.

The only port of any size between Bombay and Cochin is Mormugao, a foreign port, and if only we could regard both Mormugao and the proposed port of Bhatkal as ports of India, we would ask ourselves whether from this view-point a port additional to Mormugao between Bombay and Cochin is justifiable. Arsikere which we may take as a central point of the rich Mysore country is distant from the respective ports as under:—

Mormugao	...	332 miles (calculated mileage on ghat section).
Madras	...	325 miles
Bhatkal	...	179 miles

The opening of the last-named as a port will greatly reduce rail haulage from the coast to this part of the hinterland, and this factor is of great importance, particularly with new industry. The industrial district is going to be round the new electric power works at the Jog Falls and between them and Shimoga which is distant from the respective ports as under:—

Mormugao	...	...	344 miles
Madras	...	...	393 miles
Bhatkal	...	...	111 miles

There are, therefore, geographically grounds for considering the possibility of a port at Bhatkal. Such a port would divert Mysore State traffic from Madras to a figure of 50,000 to 100,000 tons a year and it is thought that it might affect Mormugao to a somewhat similar extent. At the same time the hinterland of Bhatkal consisting of the rich and progressive Mysore State would be very much better served by this nearby port than by the more distant harbours of Madras and Mormugao. There is not a great deal to be gained by laying out a new port which has only the merit of diverting cargoes from other ports, but this proposal would definitely be an assistance to the development of Mysore. The question really is one of rupees, annas and pies, and this is dealt with in the two succeeding paragraphs.

A Survey of Indian Ports—continued

Traffic Prospects.

The General Manager gave the Committee an interesting survey of traffic prospects of the port and railway and this is summarised in tons as follows:—

118,000	Imports of existing trade,
30,550	Exports of existing trade,
25,000	Expected traffic to and from country in neighbourhood of port,
61,500	Traffic from the Shimoga-Bhatkal Line,
315,000	Traffic to be newly developed.
Total 550,050	

The Committee discussed this estimate at some length and is inclined to think that the figures are to some extent an overestimate. For instance, there are not very good grounds for anticipating 25,000 tons of local traffic, nor as much as 61,500 tons of traffic from the Bhatkal-Shimoga Line. As regard new traffic, the figure of 315,000 tons includes export of 70,000 tons of steel castings, pig iron and manufactured iron and steel articles, also 10,000 tons of sugar from the new irrigation areas surplus to the State's own requirements and those of the neighbouring provincial areas, and finally 40,000 tons of surplus grain. The Committee could not itself conduct a traffic survey but it considers that the figures quoted above are on the high side and that the figure of total trade is unlikely to exceed annually, say, 400,000 tons, for many years to come.

Financial Implications.

(a) It is not very easy to estimate the return to be expected on a combined port and railway venture without a detailed enquiry by railway and port experts which will take a long time. The Committee at this stage, however, makes the following rough calculation:—

	Rs.
Capital cost of Talguppa-Bhatkal Railway ...	1,10,00,000
Capital cost of Port	1,44,00,000
Total	2,54,00,000

Interest on Port capital cost of Rs. 1,44,00,000 at 3% is Rs. 4,32,000. Repayment of loan advanced to the port in 60 years on the usual terms allowed to Port Trusts at 0.6% is Rs. 86400. Total annual debt charges—Rs. 4,32,000 plus Rs. 86,400 = Rs. 5,18,400.

(b) The annual traffic earnings on Port traffic at, say, Rs. 2 per ton would on 400,000 tons amount to Rs. 8,00,000, and as against this operation and maintenance are likely to cost not less than Rs. 3,00,000 a year. This shows a total debit on the port working of Rs. 8,18,400 against a credit of Rs. 8,00,000. There will, however, be additional receipts from ships' dues, warehouse charges, and other income incidental to the working of a Port Trust.

(c) This then means that the investment on the port will be able to earn not less than 3%. This cannot be called an uneconomic proposition. The Committee, therefore, considers that, on the data submitted it is both a practical and good financial proposition. Moreover, the Committee is of the opinion that the development of Bhatkal as a major port is essential for providing a good economic outlet for the trade of the large and rich hinterland of the Mysore State lying behind it. In view, however, of the fact that the engineering report and part of the traffic estimate were made a generation ago, the Committee considers it necessary that a fresh report regarding the engineering possibility of the scheme and fresh data should be called for.

VIZHINJAM

The site of Vizhinjam is a Bay on the west coast of Travancore State 9 miles south of Trivandrum, between that place and Cape Comorin and about 120 miles distant from the major port of Cochin. The remoteness of the ports of Alleppey and Cochin which serve Travancore through the canal system is said to be proving a serious handicap to industrial expansion of the southern part of the State. The present facilities for sea traffic in this area extend mainly to beach loading and unloading, and in the monsoon season all work is suspended.

A port is proposed at this place primarily in the interests of the mineral traffic to Europe and America, the most important item being ilmenite, large deposits of which are to be found in the neighbourhood. Particulars of the project have been given to the Committee by the Dewan of the Travancore State, but whether the expected traffic will materialise is uncertain. There is no proposal to build a quay port, but only to provide sheltered moorings in the Bay where ships can lie at anchor to receive cargo brought to them from the interior or along the coast by country craft. Villinjam (Vizhinjam) Bay lies at the scoured end of an extensive rock promontory standing out about half-a-mile and is about one-and-a-quarter miles long terminating northward at Kovalum point. The bay is a shallow segment in shape measuring about 2 miles long and a little under half-a-mile wide. It is rounded off at the southern end by another rocky headland of less extent than the northern one. The northern promontory shelters a cove extending some 300 yards behind the point, in which deep water is maintained by scour round the headland. In the area of the bay the 5 and 10 fathom lines are close inshore, the former being at some 300 yards and the latter at about three-quarters-of-a-mile out. The set of the waves is approximately coincident with the long axis of the bay, and the beach is generally steep. At about a quarter way point on the perimeter a finger of rock from the higher ground behind bears down into the sea and causes a shallowing of the sand beds. These rocks roughly mark the limit of the sheltered area.

Model of East Wharf, Port of Karachi

Envisaging the enclosure of the more sheltered part of the bay, an area of some 40 acres might lie within the back-waters. But an examination has proved there is available some 60 acres of backland which could be conveniently brought into the harbour area. A large portion of this is not more than one or two feet above sea level, and the remainder is little higher than 10-ft.

Briefly, harbour works proposed consist of a groyne between the two headlands of the bay protecting the mooring area particularly on the north-west side and in addition an unknown quantity of dredging in the bay itself. Road communications are good, but linking up the area with the canal system presents some difficulty and will involve tunnelling or deep rock cutting.

A very rough estimate of cost of the project has been given as Rs. 3 crores, but this must not be regarded as an entirely satis-

A Survey of Indian Ports—continued

factory figure since a full engineering report on the scheme has not yet been received. Everything depends on the length of the groyne, its required strength to resist the monsoon and the amount of dredging to be done in the Bay. Not until the engineering report is made and studied can it be said with certainty whether or not the scheme is a practicable one.

The main point of the scheme is to provide a sheltered anchorage for ships of at least 5,000 tons, that being the size of vessel that is expected to carry the mineral traffic to countries overseas. Although minerals constitute the chief cargo in view there are other products in the hinterland behind the port such as mica and timber which will be benefited by this proposal. As an alternative to finding shipping facilities at Vizhinjam they have long distances to cover by backwater to other ports such as Quilon, Alleppey and Cochin.

It is not possible for this Committee, without seeing the engineering report above referred to, to judge whether this proposal is an economic one or not. Presumably the Travancore State will give effect to the proposed work if it is in the interest of the State itself to do so.

COCANADA

This is an important town on the East Coast of India and headquarters of a district. The value of its trade was in 1938-39, Rs. 4,62,67,263.

It is situated about 90 miles by rail south of Vizagapatam and is served by a fairly well-protected roadstead, which in cyclonic weather is said to provide the safest anchorage on the East Coast.

A report was made on this and other ports on the Madras Coast by Colonel Du Cane of the firm of Sir John Wolfe Barry, Lyster and Partners in 1920. With regard to Cocanada the report was discouraging. The Consulting Engineer thought that development in a big way would be seriously affected by the all-prevailing East Coast sand-travel and that the development of Vizagapatam into a major port would remove justification for large expenditure at Cocanada, less than 100 miles to the south of it.

In 1923, however, the Madras Government received a more optimistic report on Cocanada to some extent sponsored, but not written, by their Harbour Engineer Sir Robert Bristow. The Marine Surveyor, who actually wrote this report, gave his opinion that the conditions of sand movement affecting the port were tending towards equilibrium and that a sheltered harbourage could probably be anticipated for the future.

This anticipation is now confirmed by the Presidency Port Officer who in 1944, i.e., 20 years later, wrote a report to the Madras Government containing preliminary plans and estimates for a quay port of large size at this place. The project now stands at the stage that the Madras Government have asked the Government of India to recommend to them a competent harbour engineer to advise on the future possibilities of Cocanada as a deep-water port.

The port is served by the Madras and Southern Mahratta Broad Gauge Railway and is the distributing centre of oil imports intended for the large cities of the Kistna and Godavari deltas, such as Bezwada, Guntur, Rajahmundry. This oil is landed by means of barges from the tankers lying in the anchorage.

Moreover, the large hinterland, including the State of Hyderabad is expected to be widely developed when the great Ramapadasagar Dam project on the Godavari River comes into being. It is true that Cocanada is comparatively nearer to this hinterland than both Vizagapatam and Madras; that is, however, not the only consideration to be borne in mind in judging the necessity of developing the Cocanada Harbour into a major port, and the Committee does not consider it likely to be essential in the interests of future trade, or necessary for the purposes of defence and strategy. The Presidency Port Officer and other officers of the Madras Government are, however, emphatic that the East Coast sand problem does not exist here and that a deep sea harbour can be obtained here at a cost of only Rs, 1,18,00,000 without involving heavy commitments in maintenance dredging. The Committee is, therefore, of the opinion that the Madras Government's request for an engineering survey of the Cocanada proposal may be complied with and the report in connection with the scheme may be invited.

The Use of Ships' Appliances for Cargo Discharge at Ports

Comparison of Methods Employed

A report on "Cargo Ship Cranes as built by Demag," of Duisburg, Germany, has been prepared by Wm. P. Spofford of the Joint Intelligence Objectives Agency, Technical United States Group Control Council for Germany. The Report is published in this country by H.M. Stationery Office (F.I.A.T. Final Report No. 353, price 1/6 net.).

In the Report, Mr. Spofford discusses the advantages and disadvantages of deck cranes for cargo handling and suggests that, as high speed at sea is wasted unless a corresponding high speed turn-round in port is obtained, the use of level-luffing A.C. cranes on ships should be reconsidered. In principle, the report states, these Demag cranes are free swinging cranes having full 360° swing which means that, if placed between two hatches, they can work either one and thus simplify equal discharging time for all holds. In addition they are level-luffing cranes. In other words, they are so reeved that the load remains at the same height regardless of the position of the boom—high or low. This is particularly important for several reasons, viz.:

1. The operator, once having hoisted the load to the desired height, knows that it will stay at that height regardless of how freely he swings and luffs his boom which he can do and does do simultaneously.
2. It enables one motor to satisfactorily serve all motions thus simplifying the electric equipment and control and reducing the overall electric load on the ship's plant.
3. It makes it very easy to maintain straight line motion of load across the ship instead of in an arc which would increase the starting inertia and slow the total movement.
4. It reduces the power required for luffing to friction only which means that this key operation can be very fast and easily controlled.

These cranes are powered by a single, simple motor with on and off control, which runs continuously in one direction. This in turn makes them ideal for A.C. with squirrel-cage motors and the simplest of all electric controls. Reversing and speed control are provided by clutches and gears with 3 speeds in each direction. By this means the motor is always running at synchronous speed and, therefore, there are no resisters and lowering energy can be used to pump back into the line and thus reduce peak generator loads. Control platforms can be placed high or low as desired.

The crane is so designed that luffing and hoisting cannot be accomplished simultaneously. Swing, however, is a separate control and can be accomplished simultaneously with either hoisting or luffing.

The general scheme of operation is to lift the load directly up, also swinging if desired, until clear of rail—then luff and swing together in such manner that the load travels in substantially a straight line to the point of lowering—then lower away, swinging slightly if desired, to make a precise landing which incidentally is not easy with the burtoning system.

The operator rides on a swinging platform and thus always faces his load. If the crane is also high and properly placed, then the load is within his own vision a larger part of the time than is the case with ships winches.

Due to the simple mounting the height of crane and platform can be easily and cheaply varied to suit desires as to lifting out of the weather, better visibility, etc.—limited, of course, by stability considerations.

The basic winch has a drum divided into two parts—hoist on long section and luffing on short—with through shaft for maintaining strength and alignment.

All clutches and all the gears (except the 1 to 1 gears) are identical duplicates, thus simplifying spare parts and repairs—gears are 2.25 to 1 ratio. All parts are high quality with helical gears and all operate in oil.

It would seem better, for accurate control, to have vertical control levers instead of the present horizontal wheels. However, the wheels were fitted in order to duplicate the control on electric winches with which stevedores had become familiar.

Use of Ships' Appliances for Cargo Discharge at Ports—continued

The speed table is a little confusing because the low speeds are omitted and due to the combination table for several sizes. In order to make this clearer of understanding we append below table for one very useful size.

Maximum Operating Radius, 46-ft.; Minimum Operating Radius, 13.1-ft.; Lifting Capacity, 3 tons.

Horse-power—Hoisting 35; swing 5; luffing 5.

Hoisting Speeds: No. 1, 56-ft. per min.; No. 2, 126-ft.; and No. 3, 282-ft., or with 25 h.p. motor, then:

Hoisting Speeds: No. 1, 48-ft. per min.; No. 2, 103-ft. and No. 3, 236-ft.

In either case the luffing speed is 82-ft. per min.

For the swinging speed the 25 h.p. = 90° in 10 seconds and with the 35 h.p. motor = 90° in 7.6 seconds.

Lowering speeds are about 5% higher than hoisting.

Check of load is accomplished by plugging (reversing the control and current) the motor in the hoisting direction.

Advantages and Disadvantages

It seems pertinent to analyse why such a convenient tool is so little used by the world's shipping—probably less than one per cent. and whether developments have now reached a point where reconsideration is in order.

The overwhelming majority of the world's shipping uses winches with masts and/or king posts and booms. The system almost universally used is called "burtoning," wherein one boom is placed over the hatch and one over the side with the one winch and boom lifting the load clear of the deck—then comes the transfer of the load (which is connected to the whips from both booms) across from one boom to the other after which the second winch and boom lowers the load. Its advantages are many:

(a) It is extremely fast as only the load is moved horizontally and in a straight line whereas the crane must move not only the load but must swing itself. Obviously, with a long boom, this means considerable inertia to overcome and more power for a given speed horizontally. It is for this reason that only a level-luffing crane can hope to compete and even then this one point is in favour of burtoning. Hoisting and lowering are an off-setting point in favour of the crane as speeds are equal, and the crane can spot its load precisely, whereas burtoning must land its load wherever the boom is set.

(b) The burtoning system is more versatile as to weight capacity because being fixed, the masts and booms can be made heavy and strong enough for heavy loads and still be at no disadvantage in speed even though 90% of all ship lifts are under 3 tons. For the occasional heavy lift it is only necessary to change the rope reaving to meet the occasion. On the other hand, the crane must be designed complete for its heaviest lift and if too heavy for 90% of its work is forever penalised in much higher first cost, weight and inertia—hence slower. The heavy burtoning gear also costs more than light, but inertia is not a problem. This is the second point in favour of the old system; however, the change in reeving takes time which also means money in to-day's high-speed operations. It might seem better to design given holds for heavy lifts as will be shown later.

(c) To-day's tendency towards long booms capable of reaching the second rail track without rehandling. Here again practically the same reasoning applies as given for point (b).

(d) Type and Capacity of Power Supply. In the old days of steam auxiliaries the crane was at a great disadvantage due to piping difficulties to a moving platform—hence, it was never used. With the advent of D.C. electric auxiliary power some cranes began to be used but were usually too stingy in power and speed. Now that A.C. current is forging to the front and is generally agreed to be better for all other purposes, it has been held back due to the greater difficulty in attaining equally good speed control for deck winches. Such a crane as here described solves this problem completely and due to the advantages accruing elsewhere would probably prove cheaper for the whole ship than the old system. Incidentally Demag also makes cargo winches on exactly the same electro-mechanical speed reversing control system as the deck cranes.

From the above, either one would solve the A.C. problem. However, one crane will do almost the same work as two winches of equal power, and the two winches can and do overlap—hence, larger generator capacity must be supplied for the burtoning system, larger wiring, etc.

This raises the question of relative cost. Unfortunately most electric costs in Germany emanated from Berlin, and, at present, no figures are available. The Hamburg-Amerika Line estimated their ship cranes were 10% higher in first cost than the standard equipment. Demag estimated it as equal when first cost of masts, booms, blocks, reeving, etc., were all considered—one crane versus two winches and booms. It is felt that in the old days, when two winches and two booms per hatch were standard, the crane was more expensive, but when considering modern ships with suitable combinations, as will be described later, it is felt that the overall cost—for a given speed of handling—of generators, wiring and cargo equipment will actually be lower for the crane combination. Stevedore cost is an important factor as one man on a crane does the work of two with burtoning.

When a ship arrives in port she must raise and spot the booms and open and clear the hatches before actually starting to unload. With the burtoning system this operation requires a fair crew of men due to the awkwardness of boom movement and in many places the stevedores insist on taking over this job—also securing for sea—and this amounts to considerable cost and, what is more important, time. For these operations, the cranes have a very distinct advantage with their accurate and fast handling.

(e) Safety and Vision. The cranes, being completely independent, are safer than burtoning as in the latter, while traversing, one winch must pull against the other—with low booms—and can and do exert considerable strain on the whips.

Cranes can be elevated more cheaply than winches and booms and, when properly placed—plus their inherent feature of having the operator always facing the load—can keep the load in sight the majority of the time which means more speed with equal safety due to less dependence on the signal man.

The ability of the crane, placed between hatches, to work either one is a decided asset not possessed by the burtoning system. This will be covered in more detail later.

Best Application for Cranes Aboard Ship

Modern ship owners have realised that they need fast ships to obtain and hold business and that high speed at sea is wasted unless an equally high speed turn-round in port is obtained. To accomplish this objective, most modern cargo ships show much thought has been given to good equal stowage in holds plus plenty of winches and long booms—usually four to each large hold. This growing tendency, plus electric winches, means large generating plants, and the growing demand for A.C. with its lowered first and maintenance costs, presents still another problem. It is felt that these new conditions impel reconsideration of ship cranes at least in part. The next thought is how to attain their good features and avoid their bad.

As to the heavy lift problem, it is felt that this, except for very special trades, can be confined to two holds—preferably the two largest—and taken care of by one mast with four winches and four normal 5-ton booms plus a heavy lift boom on each side of mast in centre of hatch to be used as swinging booms. Prevalent heavy lifts would, of course, change the detail of the 5-ton booms to 10 or more as required. For the remainder of the ship, 3-ton cranes should be adequate and desirable.

The next most serious problem is outreach. It is immediately obvious that a crane, placed midway between centre of hatch and far landing point, instead of in the centre of the ship could have much greater reach for a given size thus saving much cost and weight. Some special liners might be able to always work the same side but, generally speaking, any ship must be prepared to work either side or even both at once—in open roadsteads for instance, or dock one side and barge the other.

As double the number of cranes—port and starboard, can hardly be justified, much thought has been given to the idea of transfer from side to side as needed—usually once to a given dock. Demag advised that they had made some careful studies on this point but finally found—due to necessary stability, securing for sea, transfer, wiring and other problems—that it was about as cheap to provide the additional crane—this, particularly when considering the ability

Use of Ships' Appliances for Cargo Discharge at Ports—continued

for working both sides at once. In view of this study they devised a scheme whereby every crane can be used for either the forward or after-hold for either side of ship. It involves, however, somewhat dangerous operations, and in some cases 180° swing, and does not seem the ideal solution.

Eighty-four of these units were installed by the Hugo Stinnes Line (repeat orders) for the Russian Trade and appear to be installed on this arrangement.

Incidentally, the study on transferring from side to side showed that this scheme would clutter up the deck and ruin it for deck loads.

The idea of placing the cranes off centre has definite merit providing the offshore cranes can reach the first track as it then permits the onshore cranes to reach the second track without being of undue size and weight. Placing the cranes at opposite ends of the hatch, however, instead of the same end, permits safer faster working, but, of course, in that case the end cranes can only work the one hatch adjacent.

As to size—3 tons is considered most suitable; 18 metres (58-5-ft.) is the maximum obtainable outreach with this Demag design and 16 metres (52-ft.) would seem nearly correct on the off centre basis. Assume 20-ft. wide hatches, 60-ft. ship width, and the cranes staggered each 8-ft. off centre. Then cranes are clear of deck loads and the offshore crane will reach 14.5-ft. beyond the side of ship and the onshore 30,5-ft. This against 22.5-ft. reach if all were on centre.

To make the picture clearer, consider the ideal future ship—say with engines aft and No. 1 hold possibly refrigerated or part liquid cargo. There would be five holds and hatches, the two forward and the after-hold being short for safety in collision, grounding, etc., and the two centre holds and hatches large enough for maximum cargo efficiency, including bulky and heavy cargo. There would be mast, winches and booms—four—between the two large hatches plus heavy lift equipment as desired. Main quarters would be over the machinery space and forward deckhouse between Nos. 2 and 3 hatches. For the rest of the cargo gear, 3-ton 14 metre (45.5-ft.) cranes would be provided as follows: one forward No. 1 hatch starboard, one forward No. 2 port, one aft of No. 2 (forward of deckhouse), starboard, one aft of deckhouse, forward end, No. 3 port, one aft starboard side No. 4, and one aft port side No. 5.

With the above arrangement one piece of equipment at every hatch can make the far reach, centre holds always have double gear if desired and doubled gear can be used for any of the holds if and when needed. This is accomplished with 10 motors (6 cranes and 4 winches) and one set of king posts and 4 booms which gives more flexibility than the older scheme using 14 motors (winches), 4 sets of king posts and 14 booms because the latter scheme only has single gear for the two end hatches.

After all the total turn-round speed is no faster than the slowest hold, and considering the reduced generator plant, wiring, etc., plus the ease of using A.C., it is felt that the proposed scheme should actually be cheaper. With reasonable planning of the cargo, the scheme should eliminate all the previous objections to ship cranes and simultaneously offer all the advantages they do, including always 10 winchmen instead of 14.

Dock Workers (Regulation of Employment) Order and Scheme, 1947

The announcement made at the end of last month by the Minister of Labour and National Service that he has completed the appointments to the new National Dock Labour Board under the above-mentioned Scheme was received while we were going to press, and therefore was too late for inclusion in our July issue. The appointments are as follows:

Chairman. The Right Honourable Lord Ammon, D.L., J.P., Chairman of the Board of Directors of the National Dock Labour Corporation, Limited, which has been the administering body for the war-time schemes of dock labour decasualisation set up under the Essential Work Orders.

Vice-Chairman. Sir Harold Montagu Barton, F.C.A., Senior partner of Messrs. Barton, Mayhew & Company, Chartered Accountants and financial director of the National Dock Labour Corporation, Limited.

Members appointed to represent dock employers on the nomination of the National Joint Council for the Port Transport Industry:

Sir (William) Nicholas Cayzer, Bart., director of Clan Steamers, Ltd., and Messrs. Cayzer, Irvine & Co., Ltd.

Mr. Alfred Howell, M.Inst.T., director and Secretary of Messrs. Roddam, Dent & Son, Ltd., and a director of the National Dock Labour Corporation, Limited.

Lt.-Col. Thomas Moncrieff Lawrie (T.D.), director of Messrs. Roxburgh, Colin Scott & Co., Ltd.

Sir (John) Douglas Ritchie, M.C., Vice-Chairman of Port of London Authority, and a director of the National Dock Labour Corporation, Limited.

Members appointed to represent dock workers on the nomination of the National Joint Council for the Port Transport Industry:

Mr. John Donovan, National Secretary of the Transport and General Workers' Union, and a director of the National Dock Labour Corporation, Limited.

Mr. Thomas William Condon, O.B.E., London area docks trade group secretary of the Transport and General Workers' Union.

Mr. Richard Barrett, general secretary of the National Amalgamated Stevedores and Dockers and a director of the National Dock Labour Corporation, Limited.

Mr. John Nathan Lisle, Newcastle District Organiser of the National Union of General and Municipal Workers, Newcastle.

The period of appointment in each case is for one year.

HIS MAJESTY'S COLONIAL SERVICE.

APPLICATIONS ARE INVITED from suitably qualified candidates for the post of Chairman of the Aden Port Trust in the Colony of Aden. Applicants should be between 40 and 45 years of age, of British nationality and physically fit, and should have had practical experience in the principal branches of port administration and have shown a special aptitude for the management and control of a port. Engineering qualifications are not essential.

The duties of the Chairman are those of the Chief Administrative and Executive Officer of the Port Trust. He has to guide, supervise and control all Departments through the Departmental Heads. He is also the Head of the Trade Registration Department. He should be energetic and capable of controlling staff of different nationalities. He will be the Chairman of the Board of Trustees and should be able to conduct meetings and place matters before the Trustees in a clear and concise manner. For dealing with new proposals, a knowledge of finance and economics will be advantageous.

Appointment will be on two years' probation for permanent and pensionable employment. Salary £1,500 per annum, plus cost of living allowance as approved from time to time (at present £150 per annum). Free furnished quarters are provided, but a small charge is made for rent of furniture. Free first-class passages are provided for the officer and, if married, for his wife, on first appointment and on leave. Home leave on full pay is usually granted on the satisfactory completion of each tour of 30 months at the rate of 7 days for each month of residential service. Income tax at local rates only. Intending candidates should write at once to the Director of Recruitment (Colonial Service), Colonial Office, 15, Victoria Street, S.W.1, stating age, professional qualifications and brief particulars of experience.

WANTED AT ONCE FOR WORK IN LONDON, Senior Engineer to take charge of a harbour extension project. He must be fully conversant with dock and harbour lay-out and able to co-ordinate, supervise and control the whole of the design work from initiation to completion, including the preparation of Contract Drawings.—Apply with full particulars of qualifications, experience, age and salary required to: Rendel, Palmer & Tritton, 55, Broadway, S.W.1.

WANTED AT ONCE IN LONDON, Civil Engineering Designers for a harbour extension project. Must possess initiative and be experienced in the design of reinforced concrete structures and harbour works generally, including railway lay-outs. Good salaries, dependent on qualifications and experience, will be paid to the right men.—Apply with full particulars to: Rendel, Palmer & Tritton, 55, Broadway, S.W.1.

WANTED AT ONCE IN LONDON, fully experienced Tracers for work on civil engineering projects. Good salaries commensurate with abilities will be paid.—Apply: Rendel, Palmer & Tritton, 55, Broadway, S.W.1.